Technical Report Documentation Page

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FHWA/CA/TL-80/24

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3. RECIPIENT'S CATALOG No.

4. TITLE AND SUBTITLE
Effects Of Roadway Runoff On Algae

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7. AUTHOR(S)
G.R. Winters and J.L. Gidley

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Sacramento, California 95819

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15. SUPPLEMENTARY NOTES
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16. ABSTRACT
Caltrans studied the effects of runoff from highway surfaces and cut slopes on the primary productivity of algae. Runoff waters from three highway sites and two cut-slope locations were tested during the winters of 1976 through 1977. Roadway runoff samples were collected near Placerville (Route 50), Walnut Creek (I-680), and Los Angeles (I-405). Cut-slope runoff was collected in the Sierra Nevada foothills. The response of indigenous algae to various levels of runoff was measured by the 5-day bioassay using the C14 Carbon uptake method. Chemical characteristics of the pavement runoff are included for samples assayed.

This report presents the findings of this study. Depending on types and concentrations of contaminants, road runoff can be either stimulatory to algal growth or, in cases where runoff comes from heavily used highways, mildly to severely inhibitory. This information will be used in assessing the environmental effects of proposed transportation projects.

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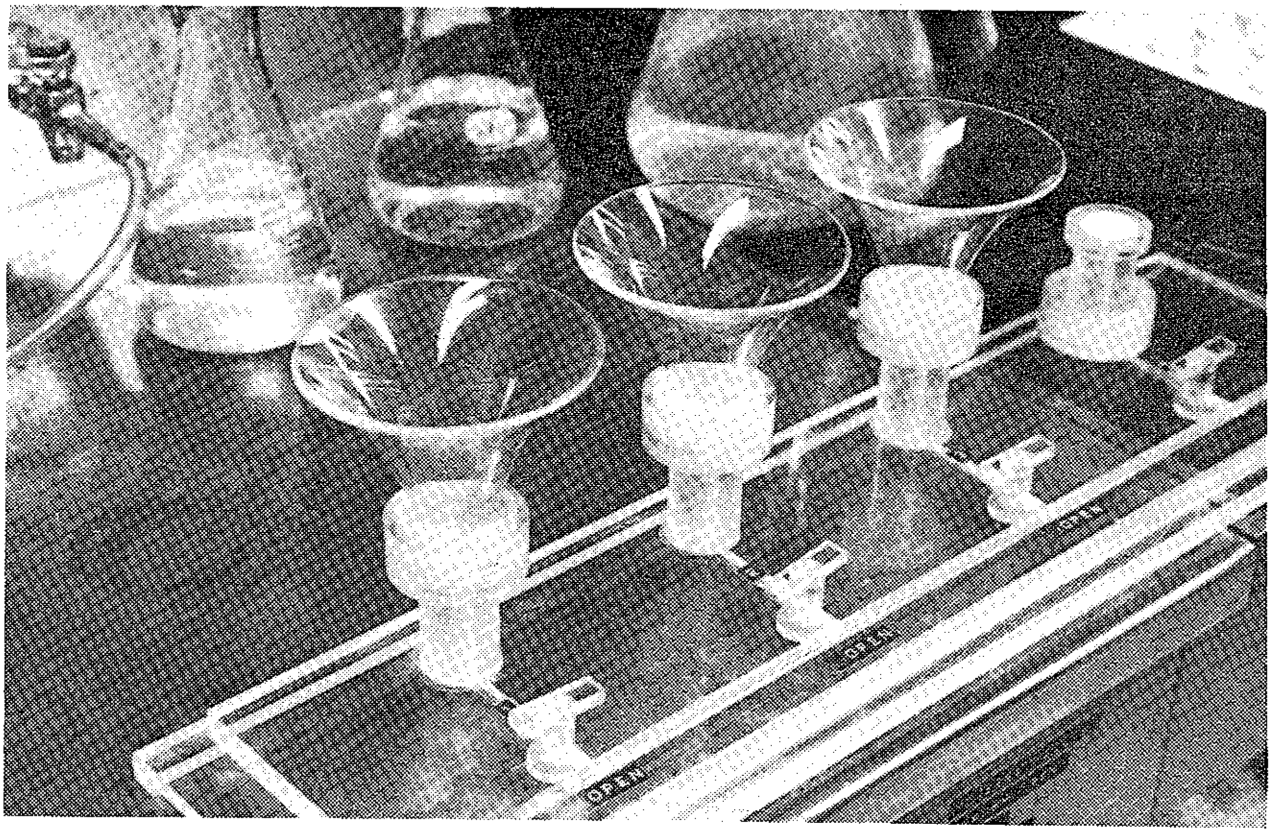
EFFECTS OF ROADWAY RUNOFF ON ALGAE

80-24



FINAL REPORT
JUNE 1980

TRANSPORTATION LABORATORY
Caltrans
CALIFORNIA DEPARTMENT OF TRANSPORTATION

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Pavement runoff, water pollution, bioassay of runoff.	No restrictions. This document is available to the public through the National Technical Information Service, Springfield, VA 22161

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STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION
DIVISION OF CONSTRUCTION
OFFICE OF TRANSPORTATION LABORATORY

June 1980

FHWA No. A-8-25
TL No. 657151

EFFECTS OF ROADWAY RUNOFF ON ALGAE

Study Made by .... Enviro-Chemical Branch

Under the Supervision of .... Earl C. Shirley, P.E.

Principal Investigator .... Richard B. Howell, P.E.

Co-Investigator .... Gary R. Winters, Biologist

Report Prepared by .... Gary R. Winters, Biologist

Assisted by .... Jeffrey L. Gidley, Biologist

APPROVED BY

Neal Andersen

NEAL ANDERSEN
Chief, Office of Transportation Laboratory

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The authors wishes to express their appreciation to the many individuals who were involved and contributed in the various phases of this project. Some of the contributors have left the California Department of Transportation and their current agency is noted.

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CONVERSION FACTORS

English to Metric System (SI) of Measurement

Quanity	English unit	Multiply by	To get metric equivalent
Length	inches (in)or(")	25.40 .02540	millimetres (mm) metres (m)
	feet (ft)or(')	.3048	metres (m)
	miles (mi)	1.609	kilometres (km)
Area	square inches (in^2) square feet (ft^2) acres	6.432×10^{-4} .09290 .4047	square metres (m^2) square metres (m^2) hectares (ha)
Volume	gallons (gal) cubic feet (ft^3) cubic yards (yd^3)	3.785 .02832 .7646	litres (l) cubic metres (m^3) cubic metres (m^3)
Volume/Time			
(Flow)	cubic feet per second (ft^3/s)	28.317	litres per second (l/s)
	gallons per minute (gal/min)	.06309	litres per second (l/s)
Mass	pounds (lb)	.4536	kilograms (kg)
Velocity	miles per hour(mph) feet per second(fps)	.4470 .3048	metres per second (m/s) metres per second (m/s)
Acceleration	feet per second squared (ft/s^2)	.3048	metres per second squared (m/s^2)
	acceleration due to force of gravity(G)	9.807	metres per second squared (m/s^2)
Weight Density	pounds per cubic (lb/ft^3)	16.02	kilograms per cubic metre (kg/m^2)
Force	pounds (lbs) kips (1000 lbs)	4.448 4.448	newtons(N) newtons (N)
Thermal Energy	British thermal unit (BTU)	1055	joules (J)
Mechanical Energy	foot-pounds(ft-lb) foot-kips (ft-k)	1.356 1.356	joules (J) joules (J)
Bending Moment or Torque	inch-pounds(ft-lbs) foot-pounds(ft-lbs)	.1130 1.356	newton-metres (Nm) newton-metres (Nm)
Pressure	pounds per square inch (psi)	6895	pascals (Pa)
	pounds per square foot (psf)	47.88	pascals (Pa)
Stress Intensity	kips per square inch square root inch (ksi $\sqrt{in}$)	1.0988	mega pascals $\sqrt{metre}$ (MPa $\sqrt{m}$)
	pounds per square inch square root inch (psi $\sqrt{in}$)	1.0988	kilo pascals $\sqrt{metre}$ (KPa $\sqrt{m}$)
Plane Angle	degrees (°)	0.0175	radians (rad)
Temperature	degrees fahrenheit (F)	$\frac{tF - 32}{1.8} = tC$	degrees celsius (°C)

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LIST OF FIGURES (Continued)

LIST OF FIGURES (Continued)

LIST OF FIGURES (Continued)

LIST OF FIGURES (Continued)

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CONCLUSIONS

1. Highway runoff has the potential to significantly affect the algal component of aquatic communities. These impacts can be inhibitory or stimulatory depending on the chemical composition of the runoff.

2. The concentration of contaminants appears to be the important aspect of road runoff that affects algal growth, whether it is inhibited or stimulated. Heavy metals appear to be the constituent which inhibits algal growth. Which metal or metals and at what concentrations they become a problem were not defined in this study. While the synergistic aspects of the various heavy metals were not investigated, it does appear that elevated levels of zinc and lead in combination are likely candidates for algal inhibition.

3. Which contaminants or combination of nutrients were responsible for stimulatory responses was not determined in this study. However, it appears that an elevated nutrient load in runoff was generally stimulatory but that the presence of metals dictated the final bioassay results.

4. The removal of particulate materials by physically filtering the roadway runoff did not significantly alter the bioassay response. Slope runoff bioassays were not extensive enough to determine the effects of filtering on algal response.

5. Runoff from suburban (Walnut Creek) and rural (Placerville) highways seems to be stimulatory in nature except when following a significant dry period which resulted in an early temporary inhibition followed by a stimulation phase.

6. Cut-slope runoff assays were limited in scope and were not extensive enough to delineate the impacts of slope runoff on algal populations.

RECOMMENDATIONS

1. This study was preliminary in nature, and follow-up research as described below should be initiated to further define the contaminants of concern to aquatic animal/plant populations.

2. Future research should define the specific runoff constituents and the levels which cause adverse aquatic impacts.

3. Future research should determine the best methods to mitigate the deleterious effects of runoff from roadway surfaces. The initial flushing of the roadway surface appears to be of primary concern.

4. Future runoff monitoring sites should be readily available to the sampling personnel for a quick response to a storm/runoff event. If close proximity to the site is not feasible automation of the site will ensure adequate sampling of the initial stages of a storm event.

5. The feasibility of using the data from this study to develop a predictive model for forecasting possible impacts of roadway/runoff on algal populations should be investigated.

6. The toxicity of roadway runoff on higher aquatic life, e.g., macrophytes, aquatic insects and fish should be inbestigated using bioassay techniques. In addition to toxicity studies, the long term effect on these organisms' reproductive potential should be investigated.

7. The final distribution and subsequent deposition of roadway originated heavy metals in a water body should be investigated, i.e., do metals distribute throughout the water body or are they relatively concentrated near highway culvert discharge points.

IMPLEMENTATION

The report will be distributed to the California Department of Transportation Headquarters Offices and Districts for their use in conducting environmental investigations.

The question of the effects of highway runoff on the environment has become one which often is asked during the environmental document review process. This report will provide a preliminary insight into this question and should be used when developing environmental reports, evaluations, and assessments related to proposed transportation projects.

TransLab will develop statements outlining the results of this investigation for inclusion in District environmental reports which must address the highway runoff question. Each project for which a statement is requested will be handled on a case by case basis to ensure the unique aspects of each project and its affected water body are considered during the evaluation of potential roadway runoff impacts.

This report will also be distributed to the Federal Highway Administration for its use.

INTRODUCTION

It has been apparent, for some time, that storm runoff from urban locations contains significant pollutants from a variety of sources. A serious urban storm-water problem exists, and in response, a significant amount of research concerning urban runoff has been initiated (1,2).

A substantial portion of urban runoff comes from road surfaces. Interest in research related to pavement runoff gained momentum during the latter 1960's and early 1970's and continues to the present time. It is now apparent, especially with the increased interest in non-point source pollution, that the highway system has the potential to contribute a wide variety and quantity of pollutants which may adversely affect the country's watercourses.

The Federal Highway Administration (FHWA) has been charged with the responsibility of identifying and mitigating highway-related pollution and has approached the problem via a multi-phased research program designed to determine:

1. The constituents and their quantities in highway runoff.

2. The sources and migration paths from the highway to receiving waters.

3. The effects on receiving waters from highway pollutants.

4. Mitigation measures for the obnoxious constituents.

In response to the first concern, the California Department of Transportation's Transportation Laboratory (TransLab) initiated a study with FHWA. The study began in the Fall of 1973 and proposed to identify and quantify the various pollution constituents found in roadway runoff. The study, entitled "Water Pollution Aspects of Particles Which Collect on Highway Surfaces", looked at runoff characteristics from three highways which carried varying amounts of traffic. Runoff from a high urbanized area (Los Angeles), a moderate traffic area (Walnut Creek) and a low traffic area (Placerville) was studied. A report of the findings was published in July 1978(3).

This report presents the results from a concurrent study conducted by TransLab which addressed the third FHWA concern and is one of the first to deal with the effects of roadway pollution on receiving waters. This study presents the findings of research conducted on the effects of roadway runoff on aquatic biota, specifically algae. The 5 day algal bioassay method was utilized as an investigative tool. In this study, algal responses to runoff, as related to concentration of specific runoff constituents, were examined.

DESCRIPTION OF FIELD SITES

Initially three road surface field sites were selected throughout California representing areas of high traffic volumes (185,000 average daily travel), medium traffic volumes (66,000 ADT) and low traffic volumes (23,000 ADT) (see Figure 1). In addition to traffic, the primary considerations for the selection of the field sites were: (1) the runoff would be rain-induced and comprised only of pavement runoff from a defined area and would not include slope or vegetation runoff, (2) the defined area would have a pavement runoff collecting system which could be used or easily modified for collecting samples at one point, and (3) the site would provide adequate safety for sampling personnel.

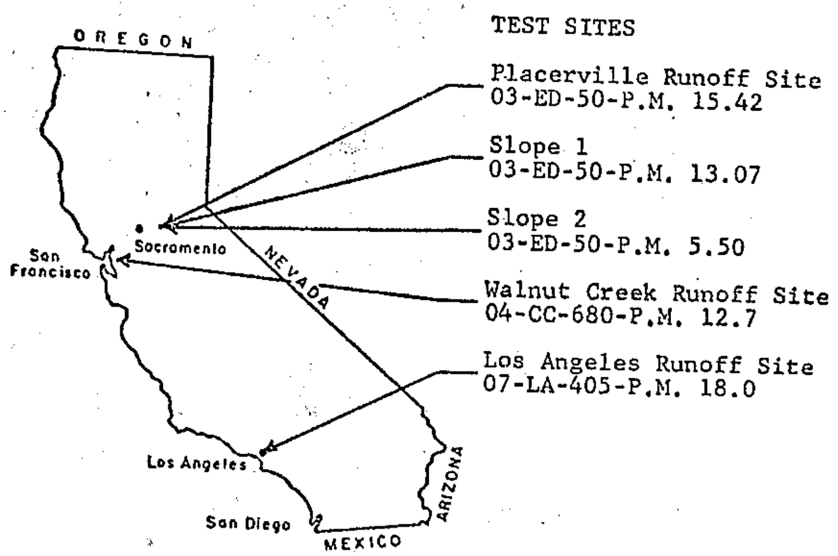
Later, two additional field sites were selected to acquire runoff samples from cut slopes (Figure 1). Due to the erratic rain patterns and low intensities experienced in California during the 1975-77 period, the major considerations for slope selection were a short distance to the sample slope, hence a better chance of acquiring a series of samples during the runoff, and safety for the sampling personnel during poor weather conditions.

Placerville Site

The Placerville site was chosen to determine runoff constituents and effects from a relatively low traffic volume highway. The average daily traffic was approximately 23,000.

The site is on Route 50 which is a 4 lane asphalt concrete (AC) Trans-Sierra all-weather highway with a New Jersey

LOCATION MAP - Highway and Slope Runoff Sites



CALIFORNIA DEPARTMENT OF TRANSPORTATION
TRANSPORTATION LABORATORY
ENVIRO-CHEMICAL BRANCH

Figure 1

median barrier and paved shoulders with gutters. The site as located in the lower Sierra Nevada foothills approximately 9 miles west of Placerville and 35 miles east of Sacramento. Figures 1 and 2 show the location of the sampling site. (Refer to the final report A-8-20, "Water Pollution Aspects of Particles Which Collect on Highway Surfaces,", for site details (3).

The site lies at an elevation of approximately 1500-1600 feet in the Foothill or Upper Sonoran Life Zone, with an annual rainfall of 40-50 inches. The vegetation in the immediate area is characterized by two distinct types, often intermingled; pine-oak woodland and brushland or chaparral. Major tree types are interior live oak (*Quercus wislizenii*), blue oak (*Q. douglasii*), digger pine (*Pinus sabiniana*) and scattered ponderosa pine (*Pinus ponderosa*). Smaller trees and bushes within the area are predominately chemise (*Adenostoma sp.*) ceanothus (*Ceanothus sp.*), yerba santo (*Eriodictyon*) *californicum*), california buckeye (*Aesculus californica*, and redbud (*Ceris occidentalis*). Vegetation along Weber Creek is primarily riparian. Land use in the immediate area is scattered residential and cattle and stock grazing in open foothill areas.

Runoff from the study area was effectively channeled down the shoulders and median of the highway in gutters to drop inlets which drained into a single corrugated metal pipe (CMP) downdrain terminating at the toe of the highway fill. Due to the channelization and dikes along the side of the roadway, runoff from this area was composed of only pavement runoff. There was no runoff from cut slopes in the sampled area. Runoff from the deck of the Weber Creek

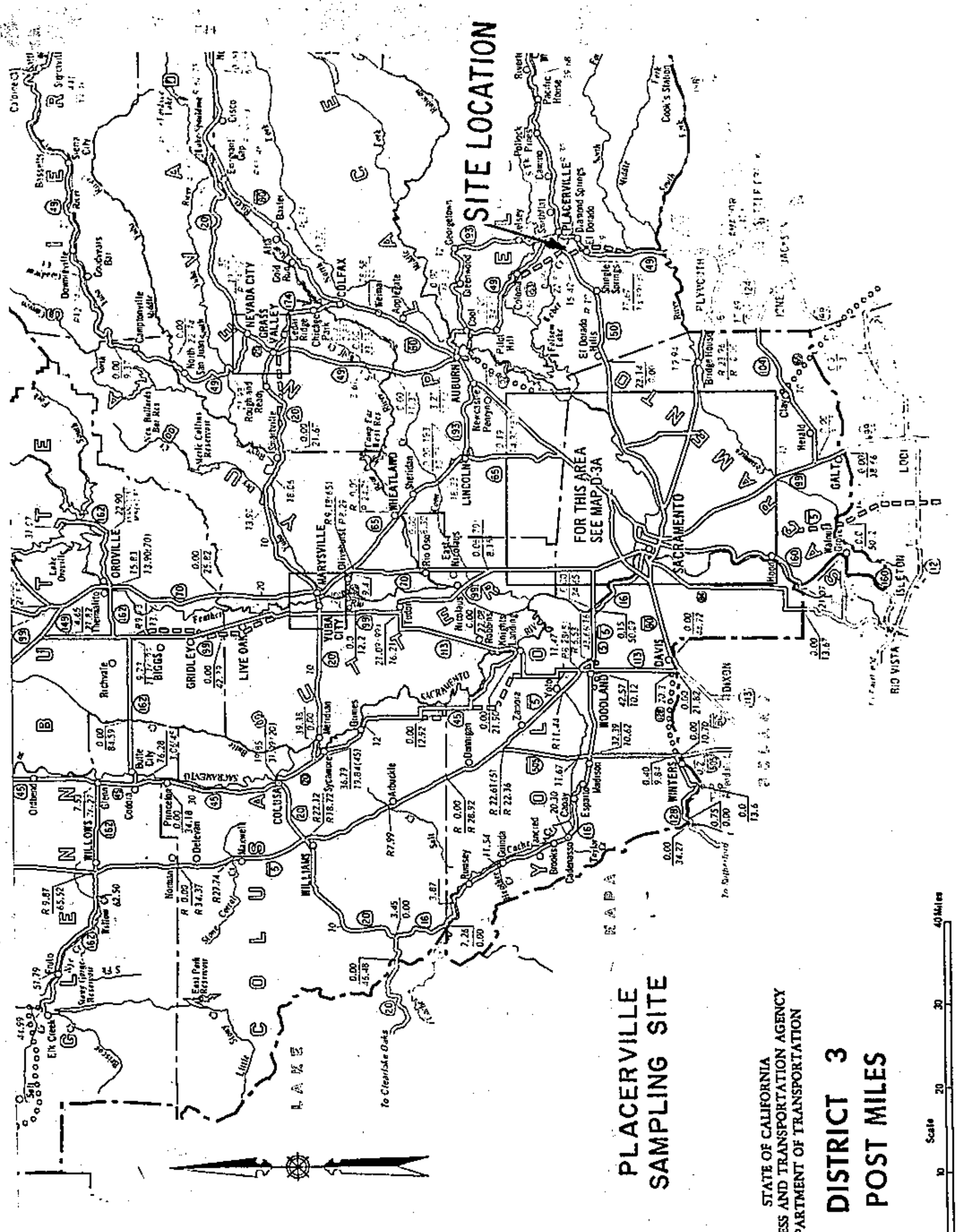

SITE LOCATION
PLACERVILLE
SACRAMENTO
AUBURN
FOR THIS AREA SEE MAP D-3A
PLACERVILLE SAMPLING SITE
STATE OF CALIFORNIA
BUSINESS AND TRANSPORTATION AGENCY
DEPARTMENT OF TRANSPORTATION
DISTRICT 3
POST MILES

Figure 2

structure did not influence the roadway runoff because the water escaped the bridge deck surface by downdrains and expansion joints transecting the deck surface.

Prior to the 1977-78 winter, samples were taken at the outlet of the CMP downdrain which discharged at the toe of the roadway fill. During the summer of 1977-78 the CMP was extended from this point so that it discharged directly into Weber Creek. To the extended CMP TransLab personnel attached a calibrated wooden Parshall flume for flow measurements.

There was no permanent sampling structure at the Placerville site and all equipment and materials were transported to the site for each storm. A four-wheel drive vehicle was normally used to gain access to the site during the 1975-77 period. During the 1977-78 winter season, TransLab's Water Quality van was used. This vehicle afforded the personnel drier working conditions for labeling and note taking as well as greater comfort during rainfalls.

Walnut Creek Site

The Walnut Creek site was chosen as a highway with medium traffic volume (66,000 ADT). The site is located on Interstate 680 south of the Route 24 turnoff for the San Francisco Bay Area, at Post Mile 12.70.

I-680 is a six-lane portland cement concrete (PCC) roadway, with AC shoulders and a New Jersey median barrier. It passes through a largely residential area with heavy concentrations of single family and multiple family structures with commercial properties in the town of Walnut Creek just north of the project site.

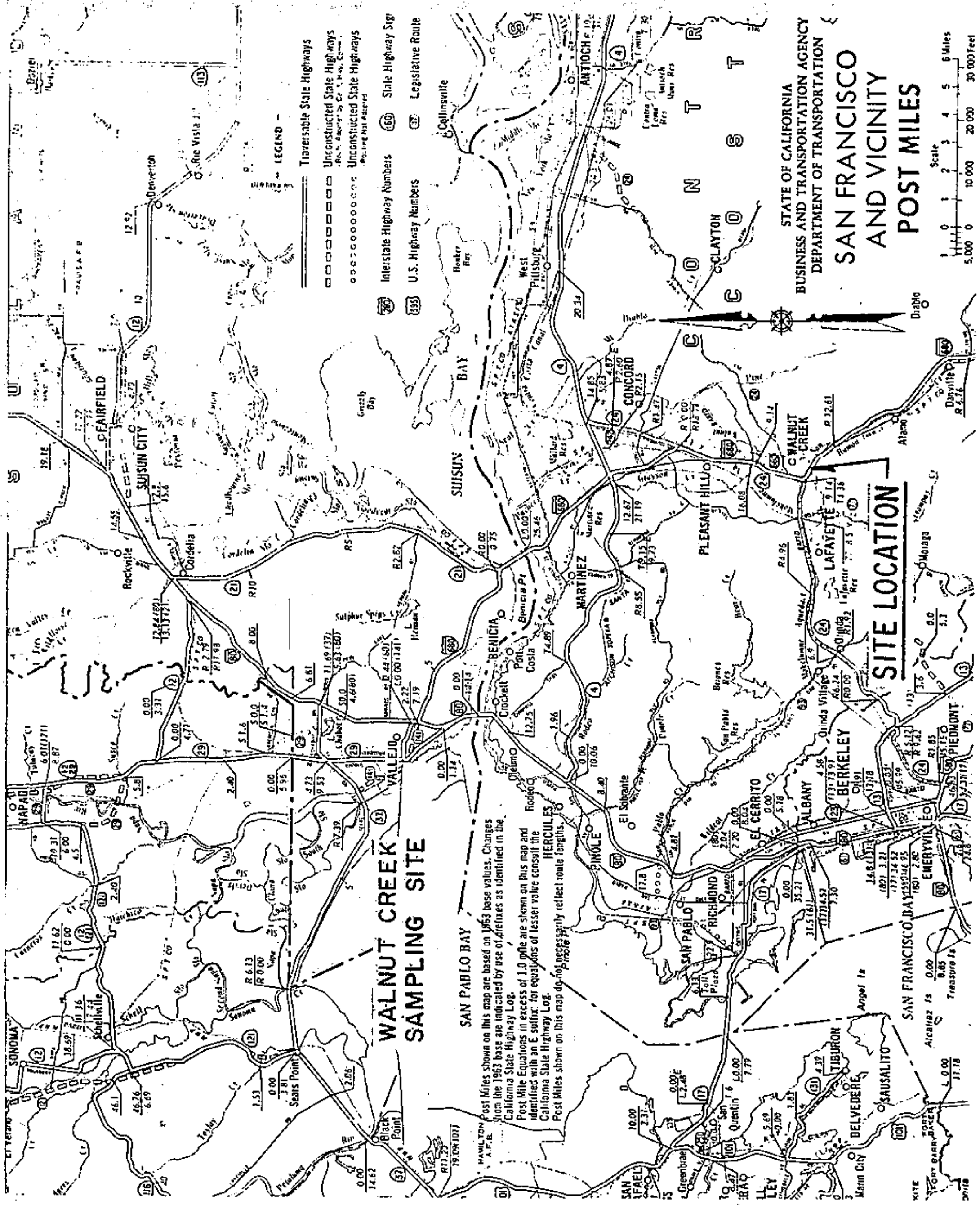

WALNUT CREEK
SAMPLING SITE
SITE LOCATION
STATE OF CALIFORNIA
BUSINESS AND TRANSPORTATION AGENCY
DEPARTMENT OF TRANSPORTATION
SAN FRANCISCO
AND VICINITY
POST MILES
SAN PABLO BAY
SUISUN BAY

Figure 3

The predominant vegetation at the study site was ornamental trees and shrubs used in highway landscaping. Prior to development this area was rolling grass foothills with scattered oaks.

The Walnut Creek sampling site included drainage from approximately 2.1 acres of freeway surface. Runoff exited the roadway surface via a series of drop inlets on each side of the roadway, which were connected by culvert, and runoff exited the west side of the freeway via a 24 inch culvert. Modifications were made by TransLab and Maintenance personnel to facilitate sampling and insure no runoff contamination from cut slope areas.

A wooden shed was used at the Walnut Creek site during the sampling periods. Monitoring equipment and sampling supplies, e.g., bottles, preservatives, etc., were stored in the shed for protection and easy access.

Los Angeles - I-405

A sampling site was selected in the Los Angeles Metropolitan area to determine the runoff constituents and effects from a freeway with very heavy use. The sampling site was on the San Diego freeway (I-405) serving the west side of the Los Angeles Basin and which carries an average daily traffic of approximately 185,000.

The site on I-405 is located approximately 4 miles south of the L.A. International Airport at P.M. 18.0. Figure 4 shows the sampling location. See the final report of Project A-8-20 for site details.

This portion of the freeway is an eight-lane PCC roadway with a chain link fence median barrier. The chain link is being replaced with a New Jersey median barrier. The area sampled was approximately 3.2 acres of roadway surface. Runoff was collected from the surface via drop inlets. Culverts on the east side of the freeway (northbound lanes) drained under the freeway where they were joined by culverts draining the southbound lanes. All of the runoff from the sampling location then exited the freeway area via a 36 inch reinforced concrete pipe (RCP) into a local drain-flood canal. The 36 inch RCP was altered with a flume and shed to serve as a sampling point during this study. Sampling supplies and equipment were kept in the shed during the winter seasons.

The site lies approximately 5 miles from the ocean. The native vegetation, removed during the commercial and residental development of the area, has been replaced with many exotics. Primary vegetation along this stretch of freeway is of the landscaping variety consisting of Eucalyptus trees, Oleander shrubs and various ground covers. Plant growth along the sampling area is quite dense, especially the Eucalyptus.

Slope Runoff Monitoring Locations

The slope runoff sites were selected to investigate the effects of highway cut slope runoff. The unusually dry conditions and abnormal rain patterns during 1975-77 necessitated selecting sites which were close to the testing facilities. Because of the unusual rain patterns, sampling personnel monitored the site when there was no appreciable runoff. During the 1975-76 and 1976-77

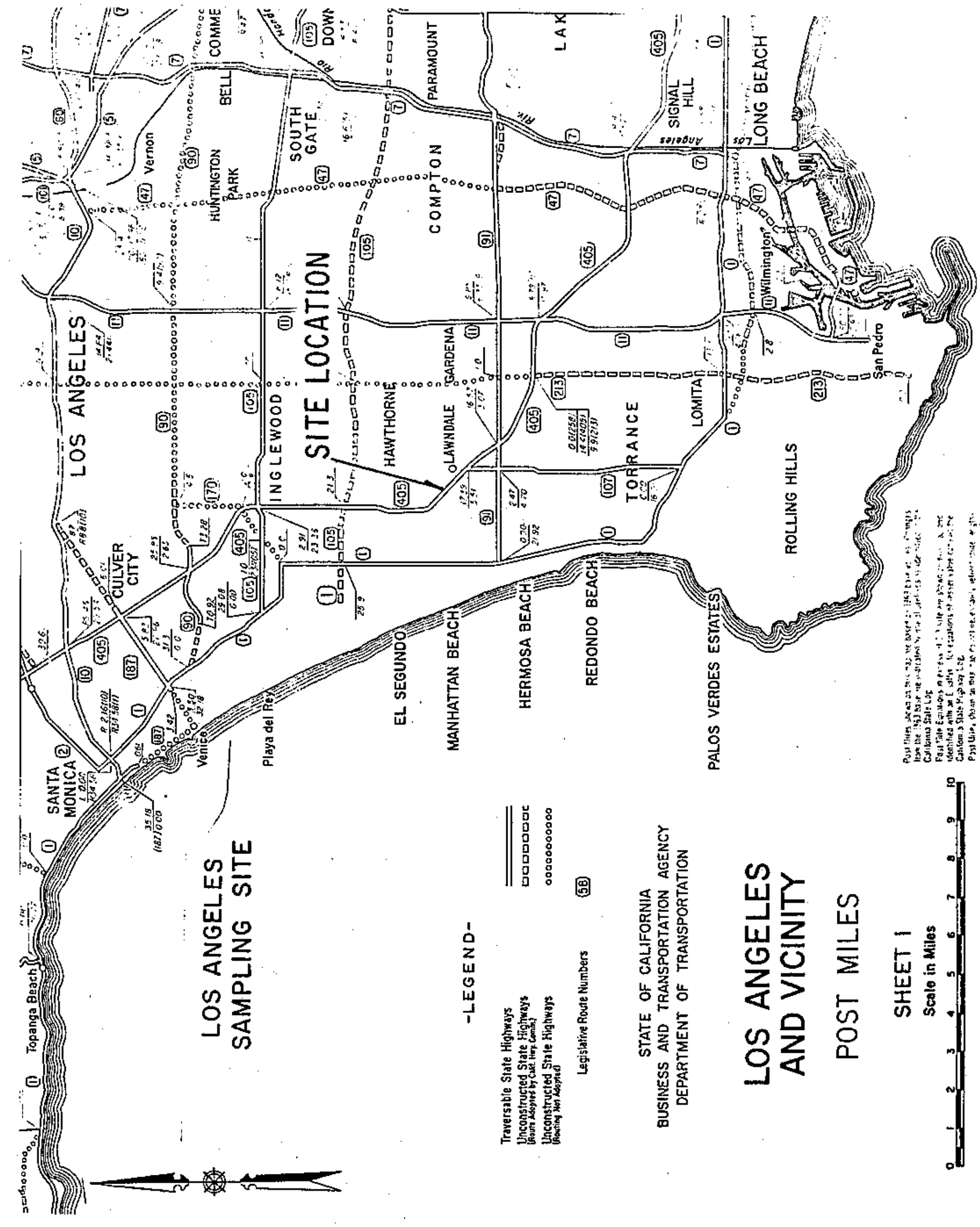

LOS ANGELES SAMPLING SITE
SITE LOCATION
LOS ANGELES
SANTA MONICA
CULVER CITY
INGLEWOOD
HAWTHORNE
LAWNDALE
GARDENA
TORRANCE
LOMITA
COMPTON
SOUTH GATE
HUNTINGTON PARK
Vernon
BELL
PARAMOUNT
SIGNAL HILL
LONG BEACH
Wilmington
San Pedro
ROLLING HILLS
PALOS VERDES ESTATES
REDONDO BEACH
HERMOSA BEACH
MANHATTAN BEACH
EL SEGUNDO
Playa del Rey
Venice
Topanga Beach
-LEGEND-
Traversable State Highways
Unconstructed State Highways
Unconstructed State Highways
Legislative Route Numbers
STATE OF CALIFORNIA
BUSINESS AND TRANSPORTATION AGENCY
DEPARTMENT OF TRANSPORTATION
LOS ANGELES AND VICINITY
POST MILES
SHEET 1
Scale in Miles

Figure 4

winters, the precipitation that did occur was absorbed by the ground with little runoff. The unusually wet 1977-78 winter allowed some sampling and bioassay work.

Both runoff sites are located on Route U.S. 50 in the lower Sierra Nevada foothills (Figure 5). Slope 1 is a north-facing slope and is located approximately 13 miles west of Placerville in El Dorado County at Post Mile 13.07 (Figures 6, 7, and 8).

Slope 2 was south-facing and is located approximately 21 miles west of Placerville at Post Mile 5.50 (Figures 9, 10, and 11).

The sites lie at approximately 1,400 feet and 1,200 feet area is primarily pine-oak woodland with large amounts of chaparral composed of Manzanita (Arctostaphylus sp), Ceanothus (Ceanothus), and Redbud (Cercis occidentalis). Digger pines (Pinus sabiniana) are the predominant tree in the immediate area. Slope 2 vegetation is primarily oak-woodland with grassland. The vegetation is the result of land clearing practices for cattle grazing. Normally this area has chaparral and oaks intermingled. Occasionally digger pines predominate. Rainfall averages approximately 35-40 inches per year.

Both Sites 1 and 2 are located in pre-Cenozoic meta-sedimentary and meta-volcanic rocks of chert variety, mostly slates, quartzites, hornfels, cherts, schists and minor marbles with relatively poor top soils. Normally soils were 1-2 feet deep over bedrock and very rocky.

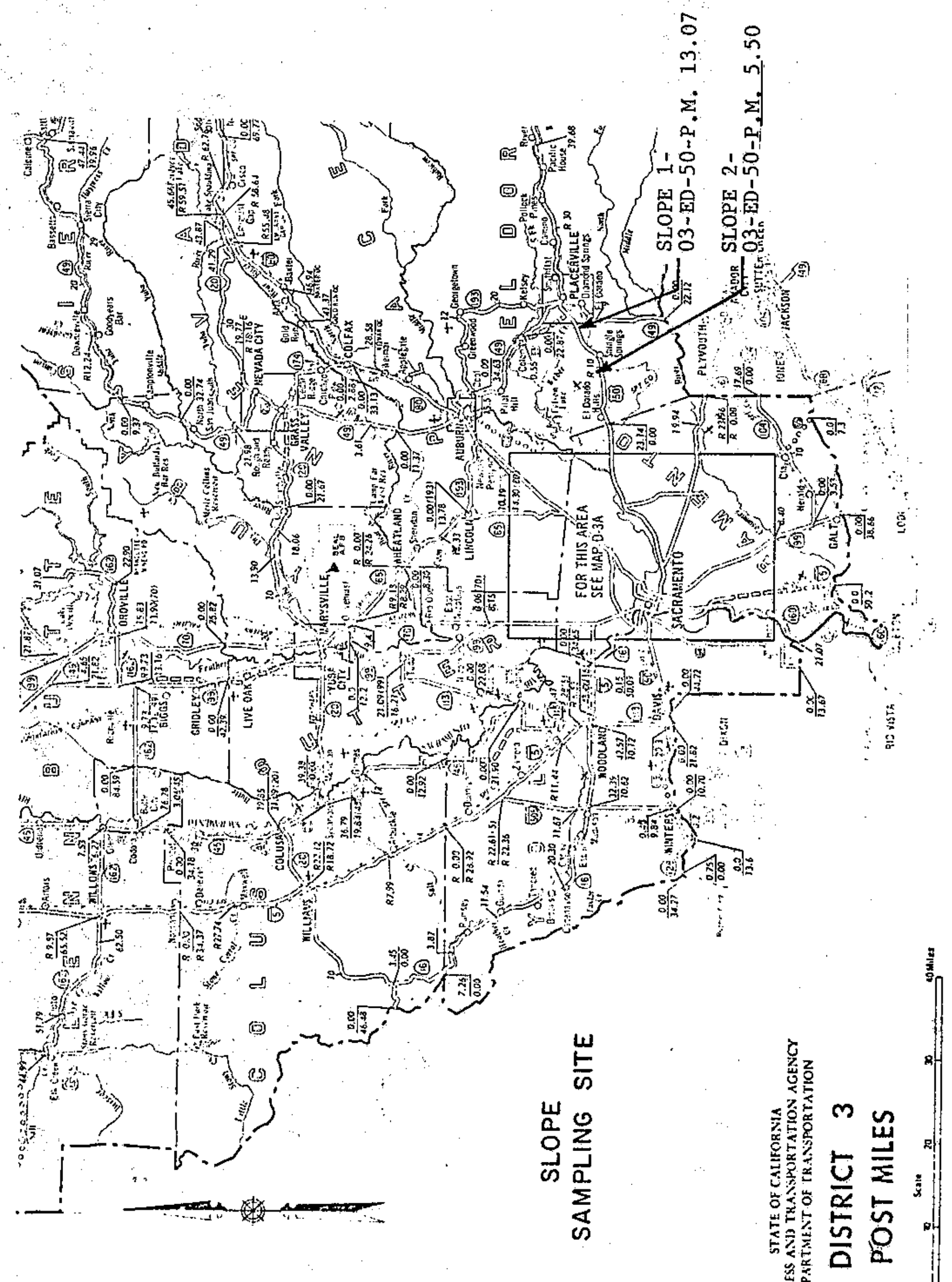
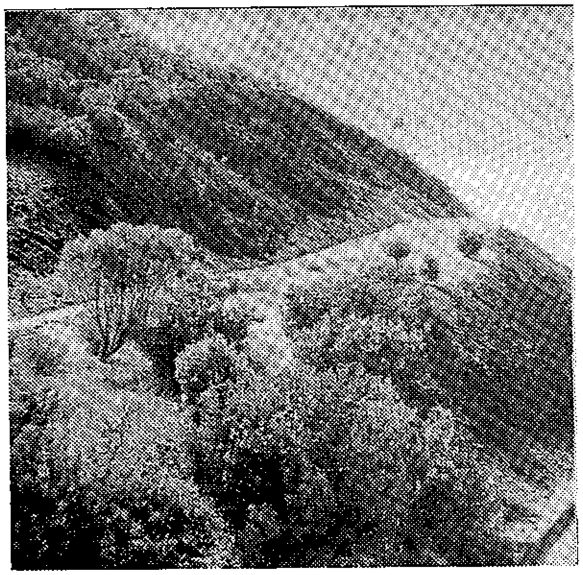

SLOPE 1-
03-ED-50-P.M. 13.07
SLOPE 2-
03-ED-50-P.M. 5.50
FOR THIS AREA
SEE MAP D-3A
SLOPE
SAMPLING SITE
STATE OF CALIFORNIA
BUSINESS AND TRANSPORTATION AGENCY
DEPARTMENT OF TRANSPORTATION
DISTRICT 3
POST MILES

Figure 5



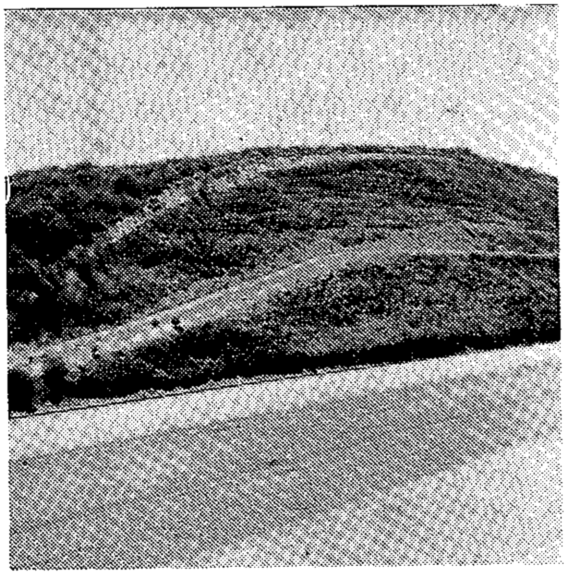


Figure 6 Slope 1 - Full View

Figure 7 Slope 1 Bench Cut Area

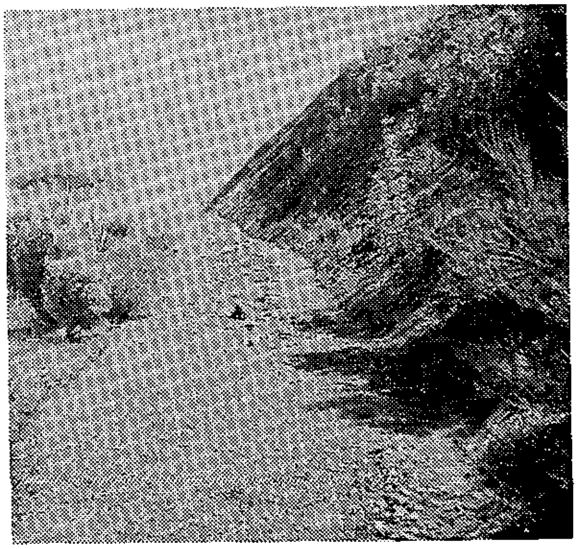


Figure 8 Slope 1 - Sampling Conducted at Outlet Asphalt Channel in Lower Right Hand Corner of Photo.

Figure 9 Slope 2 - Full View

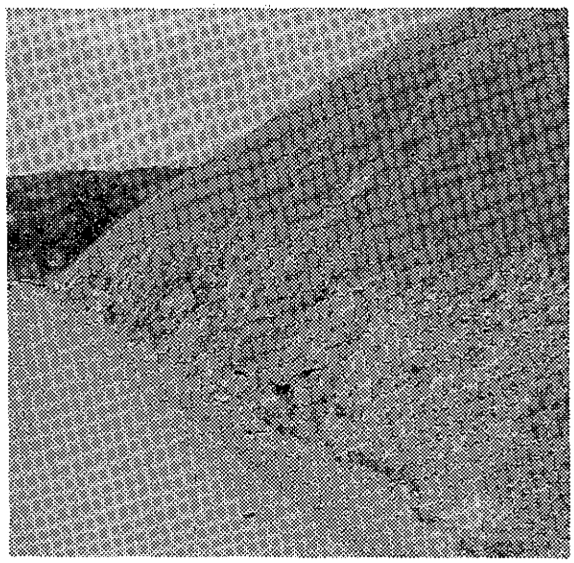


Figure 10 Slope 2 - Closeup View

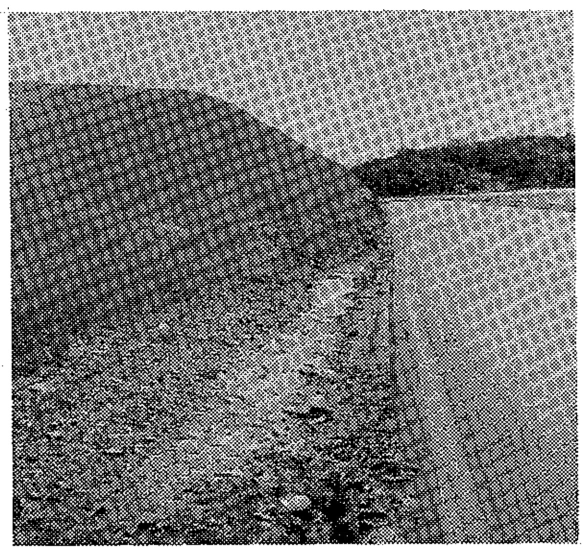


Figure 11 Sampling was Conducted in the Foreground Area of this Photo.

Monitoring Procedures and Sample Acquisition

The roadway runoff samples used in this investigation were procured from project A-8-20, "Water Pollution Aspects of Particles Which Collect on Highway Surface", which was oriented to describing the chemical constituents of roadway runoff. The reader is directed to the final report (3) for project A-8-20 for additional sampling procedures and chemical analysis details.

Briefly, a total of thirty-four parameters were determined for roadway runoff, either in the field for those parameters with little or no holding time, or analyzed in the TransLab Chemistry Laboratory. Parameters determined included:

Flow*	Carbonate
Temperature*	Boron
pH*	Silica
Specific Conductance*	Lead
Total Solids	Zinc
Volatile Portion of Total Solids	Chromium
Total Suspended Solids	Copper
Volatile Portion of Suspended Solids	Nickel
Chemical Oxygen Demand (COD)	Cadmium
Nitrogen, Kjeldahl	Iron
Nitrogen, ammonia	Sodium
Nitrogen, nitrate	Potassium
Phosphate, total	Magnesium
Phosphate, Ortho	Calcium
Oil and Grease	Manganese
Chloride	Molybdenum
Sulfate	Mercury
Bicarbonate	

*Field Measurement

At the time road-runoff samples were taken for the A-8-20 project, an additional 1/2 gallon polyethylene bottle of runoff was taken and refrigerated to 4°C using chipped ice. This sample was used to conduct the bioassay testing.

Slope-runoff was sampled when runoff was available. The slope sites were not instrumented, and the sample was taken by manually scooping slope runoff water from the runoff apron at the base of each slope. Slope samples were transported in 1/2 gallon polyethylene bottles. Refrigeration was not necessary due to the short distance from sample site to TransLab. Parameters determined on slope runoff included:

pH (Lab)	Carbonate
Specific Conductance*	Boron
Total Suspended Solids	Silica
Chemical Oxygen Demand (COD)	Lead
Nitrogen, Kjeldahl	Zinc
Nitrogen, ammonia	Iron
Nitrogen, nitrate	Sodium
Phosphate, total	Potassium
Phosphate, Ortho	Magnesium
Chloride	Calcium
Sulfate	Bicarbonate

Chemical Analyses

Chemical analyses for the A-8-20 project and the slope-runoff samples for project A-8-15 were performed by qualified analytical personnel at TransLab's Chemistry Laboratory. The laboratory is approved by the California Department of Health for all parameters tested.

*Field Measurement

In situ measurements of temperature, specific conductivity, dissolved oxygen, and pH were determined with a Martek Mark V Water Quality Analyzer or individual parameter instrumentation. Temperature was taken with a hand held calibrated thermometer, specific conductivity using a Beckman Model RA-2A Conductivity Meter, and pH using a Beckman Electromate or Leeds and Northrup Model 4717 pH meter. Dissolved oxygen was not determined at the Placerville site due to the lack of suitable instrumentation, no shelter, and the suspected aeration of runoff waters resulting from the long precipitous drop through the sampling culvert.

Major ions analyzed were: Boron by the "Curcurin Method", (Standard Methods, 1975)(4); Calcium, Potassium, Magnesium, and Sodium by the Atomic Absorption Method using a Perkin-Elmer 403 Atomic Absorption Spectrophotometer (Standard Methods 1975); Chloride by the Nitrate Method (Standard Methods 1975); Carbonate and Bicarbonate determination were by the Alkalinity Method (Standard Methods, 1975); Sulfate analysis by the Turbidimetric measurement of Barium Sulfate Crystals (Standard Methods, 1975); and Silicon Dioxide was by the Heteropoly Blue Method (Standard Methods, 1975).

Total metals were analyzed by Atomic Absorption methodology using the Perkin-Elmer 403 Atomic Absorption Spectrophotometer following acid hydrolysis (Standard Methods, 1975). Metals analyzed included, Cadmium, Chromium, Copper, Iron, Mercury, Manganese, Nickel, Lead, and Zinc.

Nutrient analysis included: Nitrate Nitrogen determined by the Brucine Method based on the reaction of the nitrate ion with brucine sulfate producing a yellow color and estimated colorimetrically (Standard Methods, 1975); Kjeldahl and Ammonia Nitrogen by distillation followed by Nesslerization and colorimetric determination (EPA, 1974)(5); and Phosphous using the Persulfate Digestion hydrolysis followed by the Ascorbic Acid-Blue Phosphoamolyesdate Method (Standard Methods, 1975).

Miscellaneous parameters analyzed included: Oil and Grease by the Partition-Gravimetric Method (Standard Methods, 1975); Total Solids and Volatile Portion, Total Suspended Solids and Volatile Portion, (Standard Methods, 1975).

The results from chemical testing of the runoff are listed in the Appendix A. The years 1976-78 are included since bioassay tests were run on various samples from these years only. The bioassay results are identified by date, sample site, and sample number. The chemical analyses for each sample can be determined using the chemical result tables. Specific parameters thought to be of importance to the bioassay results are summarized in the bioassay discussion.

Storms Bioassayed

Of the 21 storms sampled during the 1976-78 portion of the study period, samples from 12 storms were assayed. The storms sampled for chemical characterization during the 1976-78 period are listed in Table I. Additionally, the number of samples taken for chemical work, days between storms, and samples used in the bioassays are noted.

TABLE 1

Storm, Location, Dates, Samples Taken, Days Between Storms, and Samples Assayed

Year	Location	Storm No.	Date	Samples Taken	Days Between Storms	Bioassay Sample Numbers
Winter 1976-77	Placerville	2	2/8/77	12	27	1,2,6,10
		3	3/16/77	11	3	1,5,8,10
	Walnut Creek	1	10/1/76	5	3	2,3,4
		2	11/11/76	10	41	2,5
		3	12/29/76	14	45	1,3,8,15
	Los Angeles	1	12/30/76	12	48	1,5,6,7,10
		2	1/5/77	8	2	1,2,7
		3	1/20/77	8	13	1,2,6
Winter 1977-78	Placerville	1	9/19/77	4	2	
		2	11/21/77	6	15	
		3	12/11/77	5	19	
		4	12/14-15/77	10	2	
	Walnut Creek	1	10/29/77	5	29	
		2	11/21/77	13	15	1,3,8,15
		3	12/14/77	10	2	
		4	12/21/77	5	3	
	Los Angeles	1	12/21/77	6	2	
		2	1/3/78	9	5	1,5,9
		3	1/4/78	8	0	
		4	1/6/78	8	1	
		5	1/14/78	10	3	
	Slope 1	N/A	1/5/78	2	N/A	Assayed
		N/A	1/14/78	2	N/A	Assayed
	Slope 2	N/A	1/5/78	2	N/A	Assayed
		N/A	1/14/78	2	N/A	Assayed

Bioassay Procedures

The effects of roadway runoff and its contaminants on the biological components of aquatic ecosystems are not well understood. This study looked at the effects of runoff on biological systems by investigating its effects on fresh-water algae.

The 5-day algal bioassay method was employed to make the evaluation. The bioassay is a laboratory procedure in which the effects of various substances on the specific growth rate and the maximum crop of an algal population, under specified conditions, are measured. There is some degree of variability inherent in this test procedure and replications are used to permit statistical evaluation of the results. Specifically, it was intended to use this method to quantify the biological response (i.e., specific growth rate and maximum crop) of algae to changes in concentration of roadway and cut slope runoff in receiving waters. These measurements were made by adding various concentrations of runoff to water containing algae and measuring growth (or response) of the algae at appropriate intervals. The duration of the tests was 120 hours (5 days) with measurement of algal response usually at 24 hour intervals.

There are two general approaches to the algal bioassay procedure. In the first, indigenous algae found naturally in a water body can be used as the testing culture or(2) a laboratory-grown algal culture, usually a single species, can be used. The type of algal bioassay used depends on the type of work being conducted, manpower limitations, and the monitoring method used to measure algal response during the testing procedure.

For this project the indigenous algae method was chosen. Due to a lack of manpower to maintain a sufficient supply of laboratory algal culture for the large number of bioassays anticipated it was felt the laboratory culture method, using a single species algae, was not feasible. The large amount of detritus, surfactants and unknown character of roadway runoff contaminants expected during this study would negate all of the desirable characteristics for measuring results by single species bioassays.

The use of indigenous algae decreases the manpower requirements since cultures do not have to be maintained. A constant supply of water containing indigenous algae was readily available from a nearby reservoir which could be transported to the laboratory in any amount quickly and conveniently.

Algal response can be measured either as changes in cellular mass of the algal culture or by monitoring the respiration rate of the algae.

Cell mass changes as a response indicator, can be measured by several methods including optical density, weight measurements, cell counts, chlorophyll fluorescence, and chlorophyll concentration. Normally, optical density and weight measurements are applicable only for algal growth in highly enriched cultures because they are not sensitive to low concentrations of cells. Cell counting utilizing an appropriate counting chamber and microscope has been used for years and can be an effective method if the medium is dominated by one or only a few algae species of about the same general size characteristics. Unfortunately, most water bodies contain algae species which differ greatly in size requiring lengthy and tedious counting processes.

Measuring the fluorescence of chlorophyll is another method to determine cell mass. Both chlorophyll fluoresence after acetone extraction and direct fluorescence of unextracted algal cultures are used. The former requires filtration and extraction procedures resulting in a substantial time investment while the latter is rapid, very sensitive, requires small samples and can be used on both single and mixed cultures of algae.

As noted, respiratory response can also be used to monitor algal changes during testing procedures. During the ;hotosynthetic process algae take up carbon dioxide and produce oxygen as a byproduct. The measurement of CO_2 uptake and/or O_2 production can be used to determine algal response during bioassay testing. In addition to the measurement of CO_2 or O_2, the rate of carbon assimilation by algae can be used to measure algal response.

Due to the substantial amounts of particulate contaminants normally associated with roadway runoff, especially during the early stages of a storm, weight measurements and cell counting techniques would have been very difficult and of questionable validity. The excessive particulate contaminants could be expected to seriously influence the !eight determination as well as making algal counts difficult and time consuming.

Initially, it was felt the in vivo fluorescence technique for measuring chlorophyll changes would be the best method for the measurement of algal response during the bioassay procedures. The technique was attractive because of its sensitivity, small sample size requirement (approximately 10 ml), and ease of operation. However, early in the 1975-76 winter, the first samples from Placerville showed the runoff itself exhibited excessive fluorescence at the same wavelength as chlorophyll. It was apparent the amount of fluorescence present, even at the lower addition levels, was excessive and would cause serious complications by masking algal response. As a result, the fluorescence technique was abandoned and the radioactive carbon method chosen.

The carbon-14 (14^C) method for bioassay has been described in detail elsewhere and will be discussed in the Bioassay Testing Procedures section of this report(6). The method is based on the uptake of inorganic carbon by algae during the photosynthetic process. In this method, radioactive carbon, as bicarbonate, is supplied to the growing algae. As the algae assimilate carbon during their metabolic processes, they utilize radioactive carbon and become "tagged". Radioactivity is then measured as counts per minute on a Geiger-Mueller counter and is proportional to the uptake of 14^C during the algae's photosynthetic activity. In this manner, the effects of runoff additions on the growth of algae can be measured and then compared with control replicates which have received 14^C additions for monitoring but no runoff additives.

Bioassay Laboratory Equipment

Bioassays were conducted at TransLab using an 8' x 8' x 7' environmental chamber Model CEC-807 (Figure 12) manufactured by the Environator Corporation West. The chamber has a temperature range of 0° to 60°C ± 0.25°C and maintains a range of 25-90% ± 5% relative humidity over a temperature range of 10 to 50°C. Lighting for the tests was by fluorescent light tubes calibrated to provide 400 ft candles ± 10% across the assay table surface. Light uniformity was checked using a calibrated light meter.

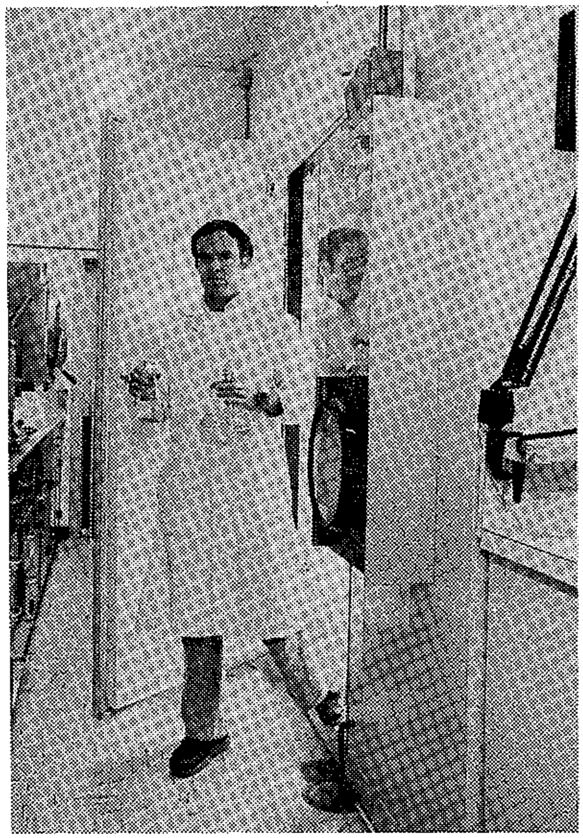


Figure 12 Environmental Chamber - Note control panel. Temperature and humidity were recorded 24 hours a day during the test procedure via a Foxboro Model 12R Recorder.

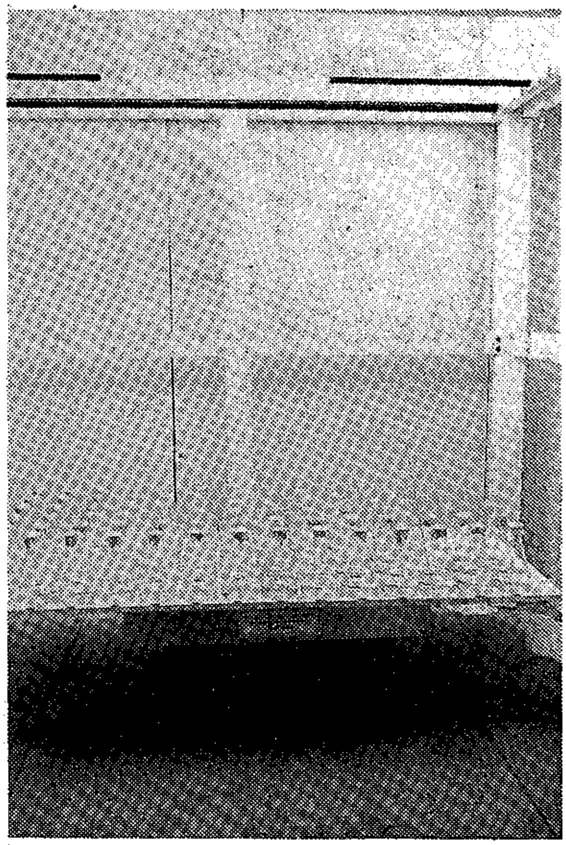


Figure 13 Inside of chamber showing light tubes and oscillating table.

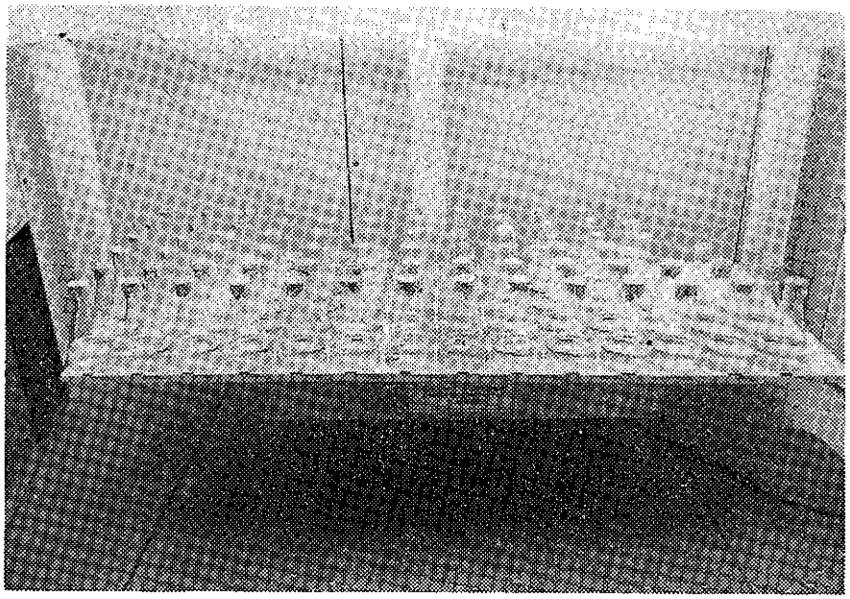


Figure 14 Eberbach Oscillating Shaker Table with assay replicates.

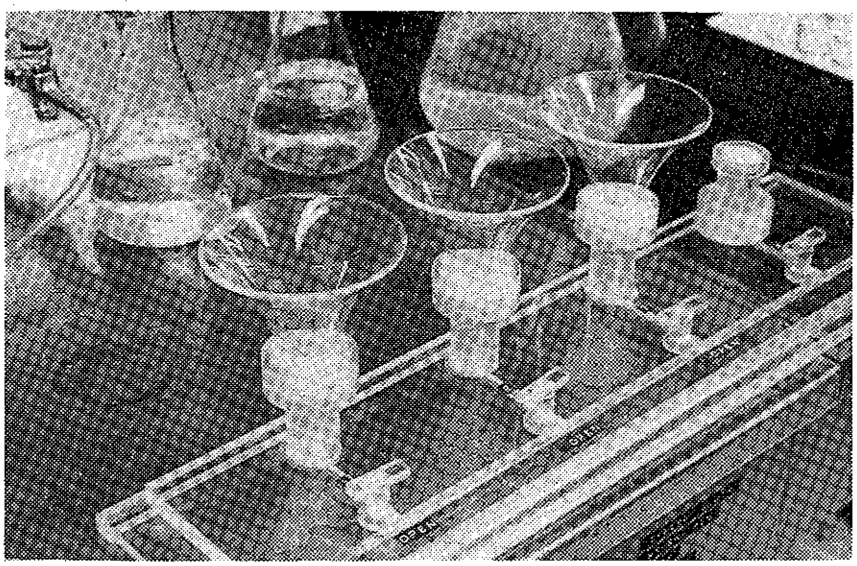


Figure 15 ^{14}C Filtering Manifold.

Bioassay flasks were rotated during the test period with an Eberbach Oscillating Shaker table with a surface built of plywood, painted white, which could accommodate 28 tests of three replicate test flasks each (84 samples) (Figures 13 and 14).

The bioassay samples were filtered using a C^{14} filter manifold with four funnels fabricated by the Min Plastics Supply Center, Honolulu, Hawaii (Figure 15). A Market Forge Sterilmatic Autoclave was used to sterilize bioassay glassware.

Bioassay Testing Procedures

Bioassays for the runoff samples were conducted using water containing an indigenous algal population from Lake Natomas. This lake is a forebay reservoir behind Nimbus Dam on the American River, approximately 20 miles east of Sacramento. Lake Natomas was selected because of its proximity to Sacramento and its indigenous algal assemblage.

Highway runoff for this study was taken as an additional grab sample during the A-8-20 research sampling. Samples were bioassayed as individual grab samples rather than flow composites for the entire storm event. Samples destined for bioassaying were collected in one-half gallon polyethylene jugs preserved in a ice chest and delivered to the biology laboratory at TransLab as quickly as possible after sampling.

Due to the large number of samples taken at the three runoff sites during a particular storm event, and the limited testing facilities available, it was necessary to select the samples within a storm for bioassay.

Generally,, the initial, middle, and the last roadway runoff sample were chosen for testing; however, this varied from time to time. Often the amount of particulate matter and the "dirtiness" of the sample was used to determine which samples would be assayed. The amount and intensity of rainfall and runoff were important variables in evaluating the samples selected for bioassay.

Prior to an algal bioassay run all glassware was autoclaved and stored in 0.1N Hydrochloric Acid (HCl) to ensure sterile conditions. The 500 ml Erlenmeyer flasks used as culture flasks were filled with 0.1N HCl, capped with aluminum foil, and stored between assays. Prior to use, they were rinsed 5 times in tap water and 5 times in deionized water. Three replicates of flasks were designated per sample type and controls. Flasks were numbered permanently on the frosted label with black waterproof ink. Replicates were numbered, e.g., 1-1, 1-2, 1-3, 2-1, 2-2, 2-3, 3-1, etc. If a flask had consistent erratic results when compared to replicates in the same series, it was discarded. Flasks were covered with loose aluminum foil caps to ensure adequate oxygen exchange while excluding dust, etc., from the assay media.

Algal bioassays were run as soon as possible after samples arrived at the laboratory to minimize unknown chemical changes which might occur during storage. Normally samples were tested within 6 hours of their collection. Los Angeles samples waited up to 12 hours depending on flight schedules. If samples were more than 12 hours old bioassays were not performed.

Samples were chosen using field notes taken at the time of collection. The field notes gave an idea of the time when samples were taken, the flow characteristics and the rainfall intensity which were useful in selecting those samples most representative of the particular storm event.

Roadway runoff concentrations in the assay culture flasks were 0.01%, 0.1%, 1.0% and 10% (i.e., 0.05 ml, 0.5 ml, 5.0 ml and 50 ml of roadway runoff per 500 ml flask; the remaining volume up to 500 ml was made up of Lake Natomas water and its assemblage of algae). The 0.01% (0.05 ml) runoff concentration had little effect on the bioassays and was terminated as a concentration level. Because the gap between the 1% (5.0 ml) and the 10% (50 ml) sample appeared excessive, a 5% (25 ml roadway runoff per 500 ml), sample concentration was added to provide information for concentrations between 1% and 10%.

In all cases controls were prepared. One control consisted of 500 ml of Lake Natomas water. No roadway runoff or distilled water was added to this control. A second set of controls was comprised of Lake Natomas water with 25 ml of distilled water for a final volume of 500 ml while a third set of controls utilized 50 ml of distilled water. The 25 and 50 ml additions of distilled water to Lake Natomas water was used to ascertain if the volumetric changes had an affect on the algal productivity during this study.

In all bioassays, fresh water from Lake Natomas was used. The lake water, with its natural assemblage of phytoplankton, upon receipt of runoff samples, was transported to the testing laboratory in 5 gallon opaque polyethylene containers. The containers were acid-washed and rinsed as described for glassware as well as rinsed numerous times with Natomas water prior to being filled. Water was taken by submerging and filling the containers approximately 6" below the surface. The containers were transported in the closed trunk of vehicles to minimize unknown light effects. Containers were not cooled because of the relatively short distance traveled (15 miles) and the cool winter weather.

At the laboratory, a small amount of radioactive carbon (10 ci/litre) in the form of radioactive Na HCO_3 (sodium bicarbonate) was added to each container. The radioactive carbon was mixed by shaking the containers of lake water top over bottom at least 30 times and rolling the capped containers on the floor for 5 minutes. After adequate mixing to ensure uniform distribution of the isotope in the lake waters, the containers were stored in the environmental chamber at 15°C without light until the bioassay flasks were ready (usually about 1 hour).

The effect of filtering particulate materials from road runoff was also investigated as a possible mitigation measure. Some runoff samples were filtered prior to assaying. Selected samples were swirled to suspend all particulate materials, and then a portion of the sample was filtered, using suction, through a Whatman No. 42 paper filter into an acid-washed and distilled water rinsed flask. The resultant runoff sample was usually heavily colored but void of particulate matter.

The appropriate number of labeled 500 ml Erlenmeyer Flask replicates were set up for the assay. The smaller amounts of runoff, such as .05 ml (.01%), .5 ml (.1%) and 5 ml (1%) were added with volumetric pipets while the large amounts of runoff, .25 ml (5%) and 50 ml (10%), were added using standard class A volumetric flasks. Controls were treated in the same manner.

After the appropriate amounts of runoff or distilled water were added to the replicate flasks, the flasks were filled to the 500 ml mark with Lake Natomas water which had previously been treated with C^{14} isotope. All the flasks were covered with loose fitting aluminum caps, fashioned from aluminum foil, and placed in the environmental chamber to incubate for 5 days at 15°C, 400 foot candles (± 10%) of light and approximately 75% relative humidity. Flasks were rotated continuously on the oscillating platform during the 5 day testing period (Figure 16). Rotating minimized chances of carbon dioxide limitation and lowering of the culture pH resulting from CO_2 absorption. Rotation of the flasks also precluded algae from adhering to the walls.

The pH determinations, taken during the bioassay runs, indicated no depression of pH. Therefore, flask rotation was continued to insure no pH related influences resulted.

Normally every 24 hours at approximately the same time each day fifty milliliters of each flask was vacuum filtered through a Millipore HA (0.45 retention size) filter (Figure 17). The flasks were swirled immediately prior to taking each aliquot.

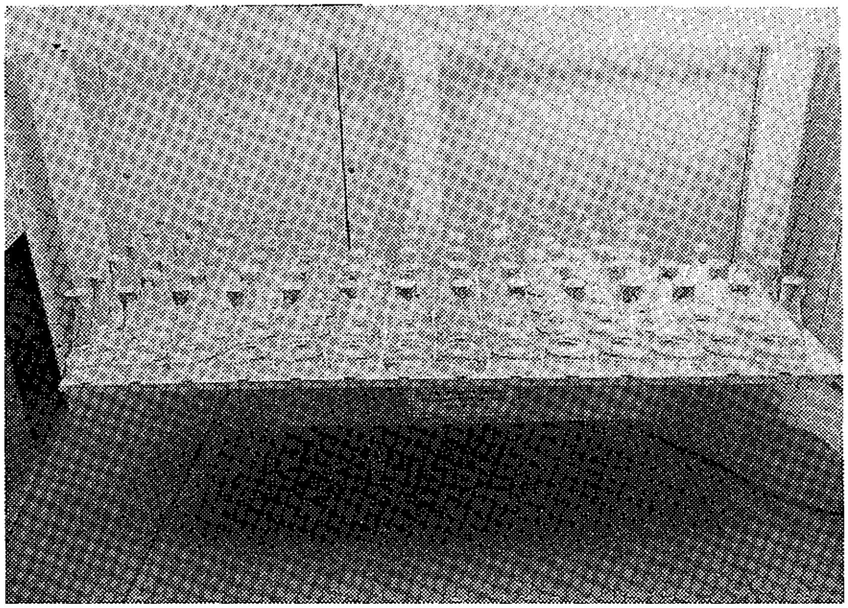


Figure 16 Bioassay Run - Capped Culture Flasks on Oscillating Platform.

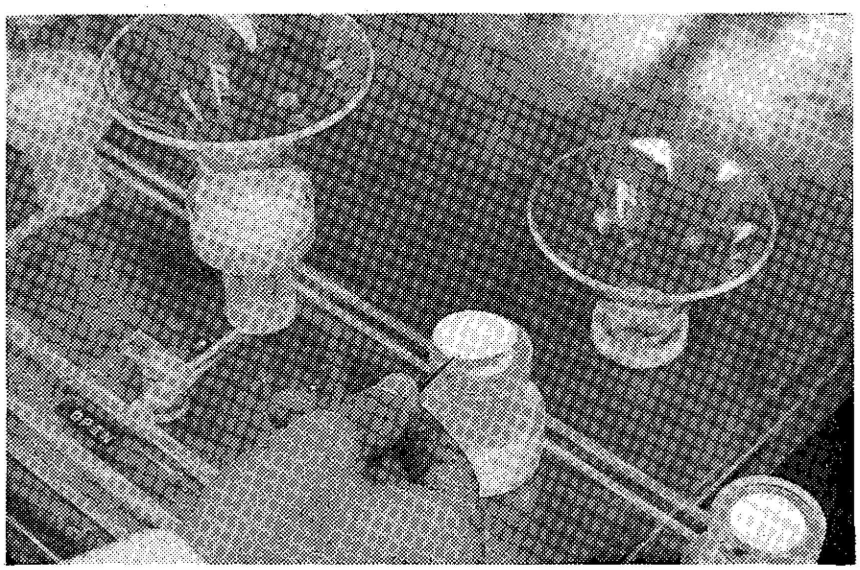


Figure 17 Vacuum Funnel and Millipore HA Filter.

The resultant filters were placed on paper towels for drying. The filters were covered with aluminum rings to ensure they dried flat and did not curl to prevent problems during the radioactivity counting (Figure 18).

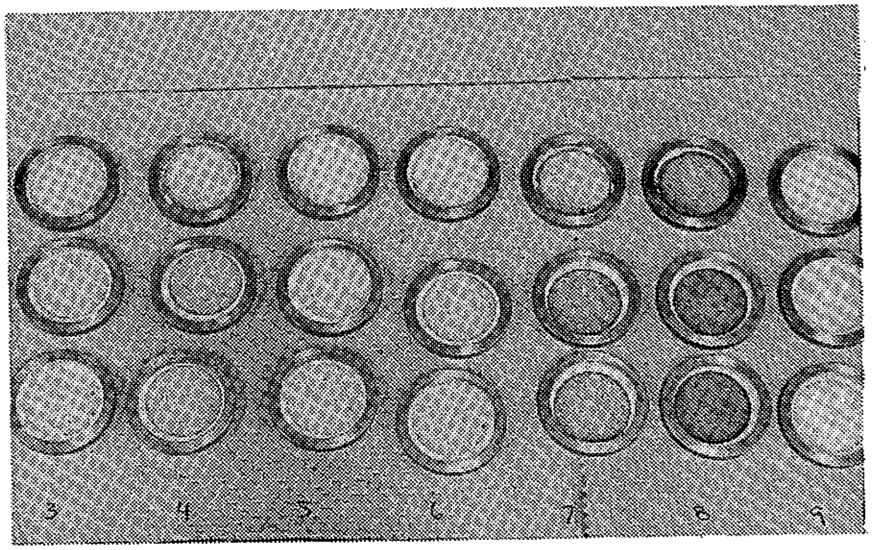


Figure 18 Millipore filters drying. Note amount of particulate material on filters.

A Geiger-Mueller counter was used to measure radioactivity on each filter. Radioactivity was measured as counts/minute and was proportional to the algal uptake of C^{14} during the test period. Results were calculated as a percent of the control. The 5% (25 ml of distilled water) and the 10% (50 ml of distilled water) controls had essentially the same results as the no-addition control. The no-additon control was used as the comparative value for evaluating flask count results for the treated assays. Average counts per replicates are shown in Appendix C.

Bioassay Results

A total of 35 road-runoff samples from 10 storms at the three monitoring sites were tested for the effects of roadway runoff on algal productivity. Two storms were studied at both slope-runoff sites. Some road runoff samples were filtered prior to the assay and compared to unfiltered aliquots of the same sample. Filter count data, analysis of variance (factorial design) and chemical analysis for the assays are in the appendix.

An analysis of variance (ANOVA) was performed on the bioassay results. This statistical method consists of dividing the total variance observed among the components which contribute to the variability plus a component that represents the variatin due to random errors and uncontrolled factors. The observed experimental means can then be compared for significant differences. Utilizing ANOVA methods, several factors may be varied simultaneously during an experiment, and information about the way these factors interact as well as information about the individual factors can be obtained.

In this experiment, ANOVA was used to compare the changes over time and the difference in concentration of highway runoff. The purpose of this comparison was to determine if (1) different concentrations of pollutants reacted in a similar manner during the experimental period (no interaction), (2) if there were significant differences among times at a given concentration and, (3) differences among concentrations of pollutants at a given time. ANOVA was also used to compare differences among samples within the same storm and to compare filtered and unfiltered treatments. Significance was set at the 95% level. The results from the ANOVA are shown in Appendix B. Significant effects are indicated with an asterisk.

The results from ANOVA were ambiguous. There was no consistent pattern of significance among the comparisons, particularly when considering interaction components. This ambiguity is probably the result of varying concentrations of pollutants between samples. This introduces differences among samples not accounted for in the analysis. These differences are potentially more significant than the concentration of the treatment or the time of sampling. The ANOVA results show consistently that when the heavy metals content of the sample are high, the effects of the concentration were significant. The method of analysis demonstrates a significant result. Previous research using the C^{14} Methodology by Goldmawand Hoffman (8) showed that a departure of the treatment from the control of $\pm 30\%$ was considered significant.

Results would be of much greater use if future experiments used known quantities of pollutants which varied independently of each other. This procedure would allow for consistent comparisons to be made among various concentration and time.

In the figures and tables to follow the bioassay results of each sample show graphically the algal response of each treatment compared to controls.

Results are grouped by monitoring site (Placerville, Walnut Creek, Los Angeles, and Slopes), year and storm. Additionally, each storm's concentration of selected runoff constituents is presented in tabular and graphical format. The constituents selected are those suspected of having either deleterious or stimulatory effects on algal productivity. For example, heavy metals such as lead and zinc are known to inhibit physiological processes. Conversely the various forms of nitrogen and phosphorus are known to result in stimulation of algal growth. Included among the roadway runoff pollutants constituents considered were: iron, total metal (excluding iron), lead, zinc, copper, nitrate nitrogen, kjeldahl nitrogen, ammonia nitrogen, total phosphorus and ortho phosphate. The chemical data for storm analyses are in Appendix B.

Table 2 is a comparison of the significant metals and nutrients found in roadway runoff and Lake Natomas waters. Appendix D lists a summary of water quality data taken on the American River below Nimbus dam for the period April 1975-Sept. 1977. This data was available through the federal STORET System operated by the California State Water Resources Control Board. All parameters considered significant in this study were monitored for Lake Natomas water for the cited two-year period. In regard to the heavy metals considered in this project, the ambient levels of Lake Natomas water were very small when compared to the roadway runoff waters. Lead in Lake Natomas water averaged .001 mg/L (10.3 g/L), well below the .4 mg/L to 8.7 mg/L range for roadway runoff found during this study. Likewise zinc at .001 mg/L and copper at less than .001 mg/L were considerably below the .16 mg/L to 22.0 mg/L zinc and .03 mg/L to .32 mg/L copper found in roadway runoff. The ambient levels of these metals in Lake Natomas water were insufficient to cause any additional inhibition during the assay period.

Likewise, nutrients found in the runoff were considerably above the ambient levels in the Lake Natomas water. Lake Natomas water nitrates averaged (NO_3) at .03 mg/L, Kjeldahl nitrogen at .13 mg/L, ammonia nitrogen at .01 mg/L, total phosphorus at .02 mg/L and ortho-phosphate averaging .01 mg/L. In comparison runoff waters ranged from .34 mg/L to 18.0 mg/L nitrate (NO_3), Kjeldahl nitrogen 1.1 mg/L to 36.0 mg/L to 17.0 mg/L, total phosphorus .13 mg/L to 1.8 mg/L and ortho-phosphate ranging from .01 mg/L to .81 mg/L. Based upon the analysis of Natomas water (Table 2) it is felt the ambient levels of nutrients did not cause additional stimulation. The assay results were primarily due to road runoff additions.

All the assays run during this research effort are outlined in Table 3. The table lists the site location, storm number and date for each sample bioassayed. The addition of runoff by percent (e.g., .01%, .1%, 1%, etc.), is listed and whether the sample was filtered. Total metals, subtracting the iron values and total nutrients for each sample are given in mg/L. The pH of the sample at assay time is also given. The total 5-day bioassay response for a particular sample and each addition is given, and the inhibitory or stimulatory nature of the assay run is listed. The percent of inhibition or stimulation for a particular runoff addition is compared to the controls. The percent of time the assay was either inhibitory or stimulatory during the 5-day test period. Bioassays with more than a 30% difference from the control are marked with an asterisk (*).

Placerville

Figure 19 through 24 graphically present the bioassay results from the second storm (February 8, 1977) at the Placerville site. The four samples assayed were collected

TABLE 2

Lake Natomas/Pavement Runoff
Constituents

	Pavement Runoff Range	Pavement Average	Lake Natomas
METALS*			
Iron	1000-76,000µg/l	11,230µg/l	161.3µg/l
Total Metals-Fe	930-33,200µg/l	4,880µg/l	90.1µg/l
Lead (Pb)	400-9,800µg/l	2,580µg/l	10.3µg/l
Zinc (Zn)	160-22,000µg/l	2,400µg/l	10.9µg/l
Copper (cu)	30-320µg/l	210µg/l	9.9µg/l
NUTRIENTS**			
Nitrate (Nitrogen)	0.35-18.0mg/l	5.98 mg/l	.03mg/l
Kjeldahl Nitrogen	1.1-36.0mg/l	14.4mg/l	.13mg/l
Ammonia	0.3-8.4mg/l	3.35mg/l	.01mg/l
Total Phosphorus	.13-1.39mg/l	.40mg/l	.02mg/l
Ortho Phosphorus	.01-.81mg/l	.12mg/l	.01mg/l

*µg/l

**mg/l

TABLE 3

Summary of Bioassay Response, Metals and Nutrients

Location Storm Sample	Addition	Total Metals Minus Iron mg/L	Total Nutrients mg/L	pH	Total Bioassay Response (% of Control)	Inhibition % of Control	Inhibition % of Test Period	Stimulation % of Control	Stimulation % of Test Period
1976-76 PLACERVILLE									
Storm 2 Sample 1	Unfiltered	33.2	31.60	6.5					
FEB. 8, 1977	.1%				84.4%	84.4%	100%	-	-
	1.0%				92.3%	80.8%	92%	106.0%	8%
	5.0%				55.6%*	55.6%*	100%	-	-
	10.0%				45.2%*	45.2%*	100%	-	-
	Filtered								
	.1%				77.4%	77.4%	100%	-	-
	1.0%				81.6%	81.6%	100%	-	-
	5.0%				64.2%*	64.2%*	100%	-	-
	10.0%				52.0%*	52.0%*	100%	-	-
Storm 2 Sample 2	Unfiltered	3.0	12.30	6.7					
	.1%				98.6%	96.6%	50%	103.0%	50%
	1.0%				104.4%	98.5%	16%	104.8%	84%
	5.0%				122.2%	89.0%	36%	132.8%*	64%
	10.0%				75.8%	71.6%	90%	110.0%	10%
	Filtered								
	.1%				99.6%	96.4%	56%	103.8%	44%
	1.0%				106.4%	98.0%	32%	108.5%	68%
	5.0%				108.2%	91.8%	81%	136.0%*	19%
	10.0%				97.2%	85.0%	82%	129.0%	18%
Storm 2 Sample 6	Unfiltered	1.8	9.00	7.6					
	.1%				112.0%	-	-	112.0%	100%
	1.0%				112.0%	-	-	112.0%	100%
	5.0%				104.8%	89.3%	63%	127.5%	37%
	10.0%				86.4%	83.4%	90%	105.0%	10%
Storm 2 Sample 10	Unfiltered	2.5	3.17	7.2					
	.1%				112.6%	-	-	112.6%	100%
	1.0%				108.2%	97.0%	30%	112.0%	70%
	5.0%				109.2%	98.0%	50%	122.0%	50%
	10.0%				81.8%	86.0%	92%	105.0%	8%
Storm 3 Sample 1	Unfiltered	1.75	4.12	9.2					
MAR. 3, 1977	.1%				111.4%	89.3%	28%	122.5%	72%
	1.0%				110.4%	97.7%	66%	120.6%	34%
	5.0%				110.2%	89.6%	60%	142.0%*	40%
	10.0%				76.0%	79.6%	60%	130.5%*	40%
Storm 3 Sample 5	Unfiltered	1.26	2.38	9.1					
	.1%				91.0%	89.2%	93%	102.0%	7%
	1.0%				101.0%	91.0%	70%	113.6%	30%
	5.0%				125.3%	-	-	125.5%	100%
	10.0%				114.4%	88.0%	48%	135.3%*	52%
Storm 3 Sample 8	Unfiltered	1.76	3.14	8.9					
	.1%				111.8%	98.8%	40%	115.5%	60%
	1.0%				123.2%	-	-	123.2%	100%
	5.0%				141.6%	-	-	141.6%*	100%
	10.0%				146.4	-	-	146.4%*	100%
Storm 3 Sample 10	Unfiltered	1.01	2.32	8.8					
	.1%				96.6%	92.3%	48%	103.0%	52%
	1.0%				107.4%	93.0%	26%	114.8%	74%
	5.0%				112.8%	98.0%	2%	111.2%	98%
	10.0%				131.2%*	94.0%	72%	144.0%*	58%

*Significant (30% variance from the controls)

TABLE 3 (Cont'd)

Summary of Bioassay Response, Metals and Nutrients

Location Storm	Sample	Addition	Total Metals Minus Iron mg/L	Total Nutrients mg/L	pH	Total Bioassay Response (% of Control)	Inhibition % of Control	Inhibition % of Test Period	Stimulation % of Control	Stimulation % of Test Period
1976-77 WALNUT CREEK										
Storm 1	Sample 2	Unfiltered	4.05	17.99	7.2					
	OCT. 1, 1976	.01%				99.0%	95.8%	80%	105.0%	20%
		.1%				99.4%	96.3%	50%	103.0%	50%
		1.0%				104.4%	99.0%	18%	104.0%	82%
		10.0%				109.2%	96.3%	48%	109.5%	52%
Storm 1	Sample 3	Unfiltered	4.18	8.96	7.1					
		.01%				95.6%	95.6%	100%	-	-
		.1%				97.4%	97.0%	86%	102.0%	14%
		1.0%				102.6%	99.0%	22%	102.8%	78%
		10.0%				119.6%	94.3%	48%	129.0%	52%
Storm 1	Sample 4	Unfiltered	4.16	8.64	7.2					
		.01%				102.0%	99.0%	20%	103.7%	80%
		.1%				98.6%	95.7%	44%	103.1%	56%
		1.0%				127.2%	-	-	127.2%	100%
		10.0%				132.4%*	-	-	132.4%*	100%
Storm 3	Sample 1	Unfiltered	6.28	64.60	10.4					
	DEC. 29-30, 1976	.01%				108.2%	95.7%	44%	113.5%	56%
		.1%				116.2%	92.5%	36%	112.6%	64%
		1.0%				114.6%	95.5%	30%	116.4%	70%
		10.0%				73.2%	72.8%	90%	101.5%	10%
Storm 3	Sample 3	Unfiltered	3.59	9.04	9.9					
		.01%				117.2%	98.0%	36%	118.2%	64%
		.1%				115.0%	95.0%	40%	118.8%	60%
		1.0%				113.0%	96.0%	32%	114.6%	68%
		10.0%				89.8%	79.5%	74%	110.3%	26%
Storm 3	Sample 8	Unfiltered	1.07	2.04	9.2					
		.01%				109.4%	91.0%	46%	118.5%	54%
		.1%				108.0%	81.5%	36%	113.2%	64%
		1.0%				111.8%	91.5%	38%	119.5%	62%
		10.0%				102.7%	80.0%	60%	122.3%	40%
Storm 3	Sample 15	Unfiltered	4.15	7.68	-					
		.01%				116.6%	94.0%	40%	125.0%	60%
		.1%				114.8%	95.0%	26%	117.2%	74%
		1.0%				112.8%	95.3%	44%	121.3%	56%
		10.0%				108.2%	81.3%	48%	124.0%	52%
1977-78 WALNUT CREEK										
Storm 2	Sample 1	Unfiltered	.93	3.30	7.5					
	NOV. 21, 1977	.1%				108.6%	-	-	108.6%	100%
		1.0%				109.6%	95.7%	36%	111.0%	64%
		5.0%				132.0%*	91.5%	28%	133.4%*	72%
		10.0%				132.8%*	88.0%	36%	136.2%	64%
Storm 2	Sample 8	Unfiltered	1.06	2.99	7.8					
		.1%				99.2%	95.8%	66%	104.3%	34%
		1.0%				119.2%	-	-	119.2%	100%
		5.0%				141.2%*	-	-	141.2%*	100%
		10.0%				150.6%*	94.5%	26%	150.6%*	74%
Storm 2	Sample 11	Unfiltered	2.67	4.79	7.4					
		.1%				102.0%	96.8%	58%	106.5%	42%
		1.0%				115.2%	-	-	115.2%	100%
		5.0%				128.6%	99.0%	22%	128.8%	78%
		10.0%				100.2%	87.3%	50%	109.5%	50%
Storm 2	Sample 13	Unfiltered	2.06	6.26	7.5					
		.1%				89.8%	89.8%	100%	-	-
		1.0%				113.8%	95.5%	28%	114.8%	72%
		5.0%				124.0%	87.5%	34%	128.8%	66%
		10.0%				84.2%	71.8%	82%	115.6%	18%

*Significant (30% variance from the controls)

TABLE 3 (Cont'd)

Summary of Bioassay Response, Metals and Nutrients

Location Storm Sample	Addition	Total Metals Minus Iron mg/L	Total Nutrients mg/L	pH	Total Bioassay Response (% of Control)	Inhibition % of Control	Inhibition % of Test Period	Stimulation % of Control	Stimulation % of Test Period
1976-77 LOS ANGELES									
Storm 1 Sample 1	Filtered	17.49	45.30	6.8					
DEC. 30, 1976	.01%				105.0%	-	-	105.0%	100%
	.1%				98.0%	97.0%	54%	103.0%	46%
	1.0%				91.5%	88.7%	86%	103.8%	14%
	10.0%				26.6%*	26.6%*	100%	-	-
	Unfiltered								
	.01%				103.0%	95.3%	56%	109.3%	44%
	.1%				99.4%	86.0%	38%	106.3%	62%
	1.0%				65.4%	65.4%	100%	-	-
	10.0%				18.6%*	18.6%*	100%	-	-
Storm 1 Sample 5	Unfiltered	8.72	18.16	6.8					
	.01%				105.8%	96.0%	40%	108.0%	60%
	.1%				102.2%	98.0%	20%	104.3%	80%
	1.0%				97.6%	83.0%	44%	115.0%	56%
	10.0%				31.8%*	31.8%	100%	-	-
Storm 1 Sample 6	Unfiltered	8.45	1.40	6.9					
	.01%				95.2%	93.4%	74%	103.0%	26%
	.1%				99.6%	95.0%	38%	103.0%	62%
	1.0%				104.0%	94.9%	34%	106.8%	66%
	10.0%				49.8%	49.8%	100%	-	-
Storm 1 Sample 7	Unfiltered	5.91	12.90	7.0					
	.01%				85.2%	85.2%	100%	-	-
	.1%				97.0%	91.0%	14%	115.0%	86%
	1.0%				85.0%	85.0%	100%	-	-
	10.0%				47.2%*	47.2%*	100%	-	-
Storm 1 Sample 10	Unfiltered	3.71	6.99	7.1					
	.01%				91.4%	91.4%	100%	-	-
	.1%				100.6%	97.0%	50%	104.5%	50%
	1.0%				94.2%	89.5%	74%	106.0%	26%
	10.0%				40.4%	40.4%	100%	-	-
Storm 2 Sample 1	Unfiltered	2.92	13.70	7.0					
MAR. 1, 1976	.01%				108.4%	96.7%	46%	112.6%	54%
	.1%				104.6%	89.0%	28%	109.0%	72%
	1.0%				94.2%	93.0%	64%	105.0%	35%
	5.0%				68.6%*	68.6%*	100%	-	-
	10.0%				45.4%*	45.4%*	100%	-	-
Storm 2 Sample 2	Unfiltered	3.25	13.00	7.1					
	.01%				107.4%	99.0%	34%	109.2%	66%
	.1%				103.8%	97.2%	54%	105.5%	46%
	1.0%				103.4%	96.0%	28%	105.4%	72%
	5.0%				79.6%	79.6%	100%	-	-
	10.0%				55.0%	55.0%	100%	-	-
Storm 2 Sample 7	Unfiltered	2.25	7.70	7.1					
	.1%				98.3%	96.6%	72%	102.4%	28%
	1.0%				103.1%	93.3%	48%	108.5%	52%
	5.0%				65.8%*	65.8%*	100%	-	-
	10.0%				53.4%*	53.4%*	100%	-	-
Storm 3 Sample 1	Unfiltered	7.48	42.50	6.3					
MAR. 16, 1976	.01%				98.4%	91.0%	64%	109.3%	36%
	.1%				104.8%	98.0%	60%	112.7%	40%
	1.0%				20.4%*	20.4%*	100%	-	-
	5.0%				9.4%*	9.4%*	100%	-	-
	10.0%				9.6%*	9.6%*	100%	-	-
	Filtered								
	.1%				103.6%	98.0%	62%	106.0%	38%
	1.0%				21.2%*	21.2%*	100%	-	-
	5.0%				12.8%*	12.8%*	100%	-	-
	10.0%				10.0%*	10.0%*	100%	-	-

*Significant (30% variance from the controls)

TABLE 3 (Cont'd)

Summary of Bioassay Response, Metals and Nutrients

Location Storm Sample	Addition	Total Metals Minus Iron mg/L	Total Nutrients mg/L	pH	Total Bioassay Response (% of Control)	Inhibition % of Control	Inhibition % of Test Period	Stimulation % of Control	Stimulation % of Test Period
1976-77 LOS ANGELES (Cont'd)									
Storm 3 Sample 2	Unfiltered	8.71	34.50	6.3					
	.01%				94.0%	94.5%	88%	101.0%	12%
	.1%				111.8%	98.0%	10%	112.6%	90%
	1.0%				79.4%	79.4%	100%	-	-
	5.0%				39.4%	39.4%	100%	-	-
	10.0%				34.4%	34.4%	100%	-	-
	Filtered								
	.01%				104.4%	-	-	104.4%	100%
	.1%				98.8%	94.0%	40%	104.0%	60%
	1.0%				83.8%	83.8%	100%	-	-
	5.0%				45.4%*	45.4%*	100%	-	-
	10.0%				40.4%*	40.4%*	100%	-	-
Storm 3 Sample 6	Unfiltered	3.99	17.30	6.5					
	.01%				100.0%	99.0%	44%	109.5%	57%
	.1%				104.2%	95.0%	52%	105.0%	48%
	1.0%				80.0%	80.0%	100%	-	-
	5.0%				37.3%*	37.3%*	100%	-	-
	10.0%				26.0%*	26.0%*	100%	-	-
	Filtered								
	.01%				104.3%	-	-	104.3%	100%
	.1%				96.0%	96.0%	100%	-	-
	1.0%				80.3%	80.3%	100%	-	-
	5.0%				38.5%*	38.5%*	100%	-	-
	10.0%				28.8%*	28.8%*	100%	-	-
1977-78 LOS ANGELES									
Storm 2 Sample 1	Unfiltered	3.8	26.40	6.3					
JAN. 3, 1978	.1%				119.0%	-	-	119.0%	100%
	1.0%				92.3%	88.4%	64%	110.0%	36%
	5.0%				55.6%*	55.6%*	100%	-	-
	10.0%				28.4%*	28.4%*	100%	-	-
Storm 2 Sample 5	Unfiltered	2.18	10.40	6.6					
	.1%				82.0%	82.0%	100%	-	-
	1.0%				86.2%	86.2%	100%	-	-
	5.0%				65.8%*	65.8%*	100%	-	-
	10.0%				49.8%*	49.8%*	100%	-	-
Storm 2 Sample 9	Unfiltered	1.78	6.30	6.4					
	.1%				102.3%	97.0%	56%	106.5%	44%
	1.0%				91.4%	86.8%	78%	101.0%	22%
	5.0%				71.4%	71.4%	100%	-	-
	10.0%				46.6%*	46.6%	100%	-	-

*Significant (30% variance from the controls)

TABLE 3 (Cont'd)

Summary of Bioassay Response, Metals and Nutrients

Location, Storm	Addition	Total Bioassay Response (% of Control)	Inhibition % of Control	Inhibition % of Test Period	Stimulation % of Control	Stimulation % of Test Period
1977-78 Slope 1						
Jan. 5, 1978 Storm	Unfiltered					
	.1%	81.8%	81.8%	100%	-	-
	1.0%	91.0%	91.8%	100%	-	-
	5.0%	94.8%	89.0%	80%	110.0%	20%
	10.0%	101.0%	95.8%	34%	104.0%	66%
Jan. 14, 1978 Storm	Unfiltered					
	.1%	71.4%	71.4%	100%	-	-
	1.0%	71.8%	71.8%	100%	-	-
	5.0%	66.6%	66.6%	100%	-	-
	10.0%	77.6%	77.6%	100%	-	-
	Filtered					
	.1%	95.0%	94.2%	90%	101.5%	10%
	1.0%	112.4%	-	-	112.4%	100%
	5.0%	101.4%	98.5%	36%	102.5%	64%
	10.0%	103.6%	93.0%	50%	109.8%	50%
Slope 2						
Jan. 5, 1978 Storm	Unfiltered					
	.1%	91.0%	-	-	91.0%	100%
	1.0%	124.8%	-	-	124.8%	100%
	5.0%	126.8%	-	-	126.8%	100%
	10.0%	120.6%	93.0%	34%	130.2%*	66%
Jan. 14, 1978 Storm	Unfiltered					
	.1%	103.4%	97.3%	68%	109.3%	32%
	1.0%	93.4%	88.3%	50%	105.4%	50%
	5.0%	82.4%	82.4%	100%	-	-
	10.0%	74.0%	74.0%	100%	-	-
	Filtered					
	.1%	80.0%	80.0%	100%	-	-
	1.0%	92.6%	92.6%	100%	-	-
	5.0%	91.0%	91.0%	100%	-	-
	10.0%	82.2%	82.2%	100%	-	-

*Significant (30% variance from the controls)

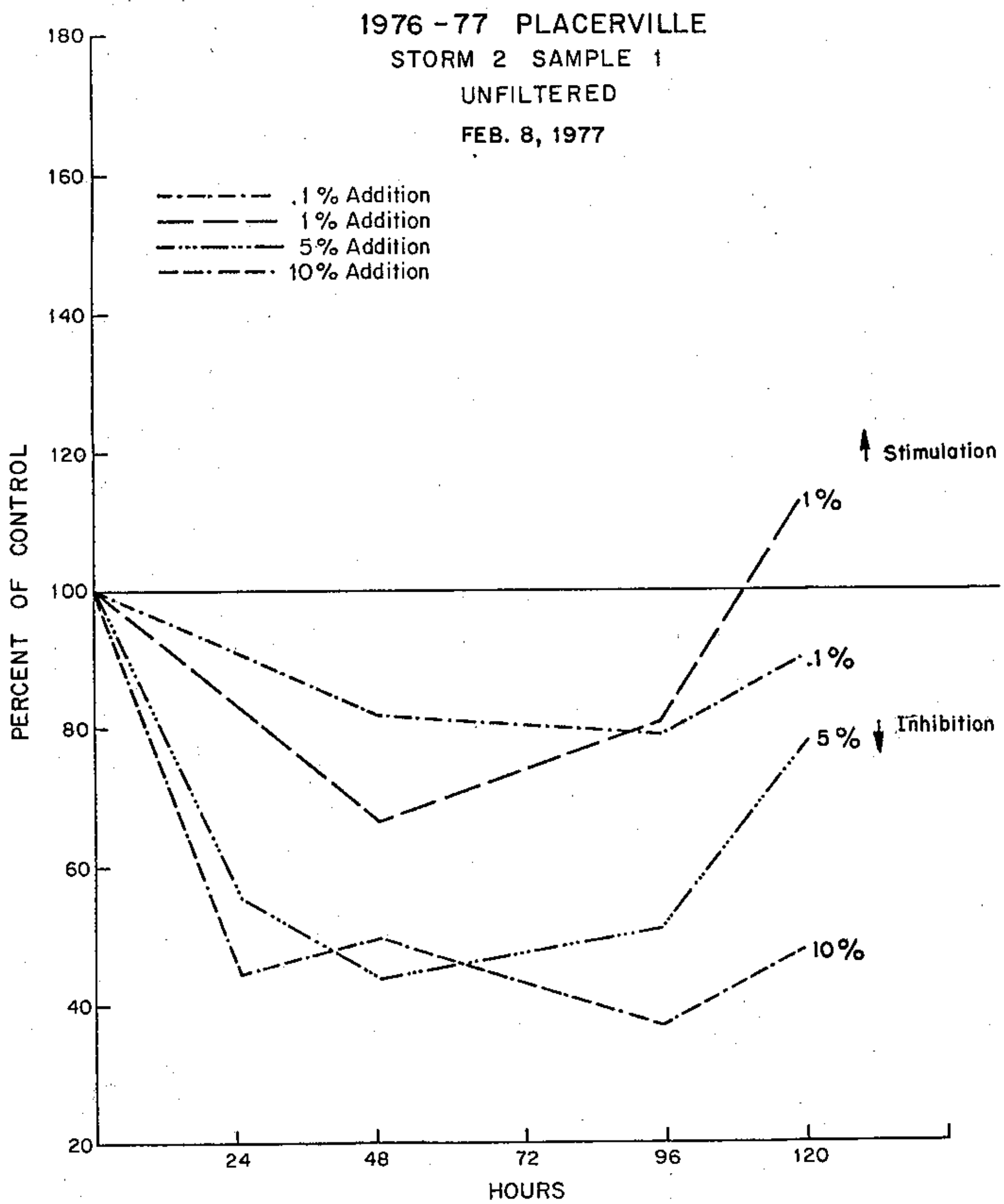

1976 -77 PLACERVILLE
STORM 2 SAMPLE 1
UNFILTERED
FEB. 8, 1977
.1 % Addition
1 % Addition
5 % Addition
10% Addition
PERCENT OF CONTROL
180
160
140
120
100
80
60
40
20
24
48
72
96
120
HOURS
Stimulation
Inhibition
1%
.1%
5 %
10%

FIGURE 19

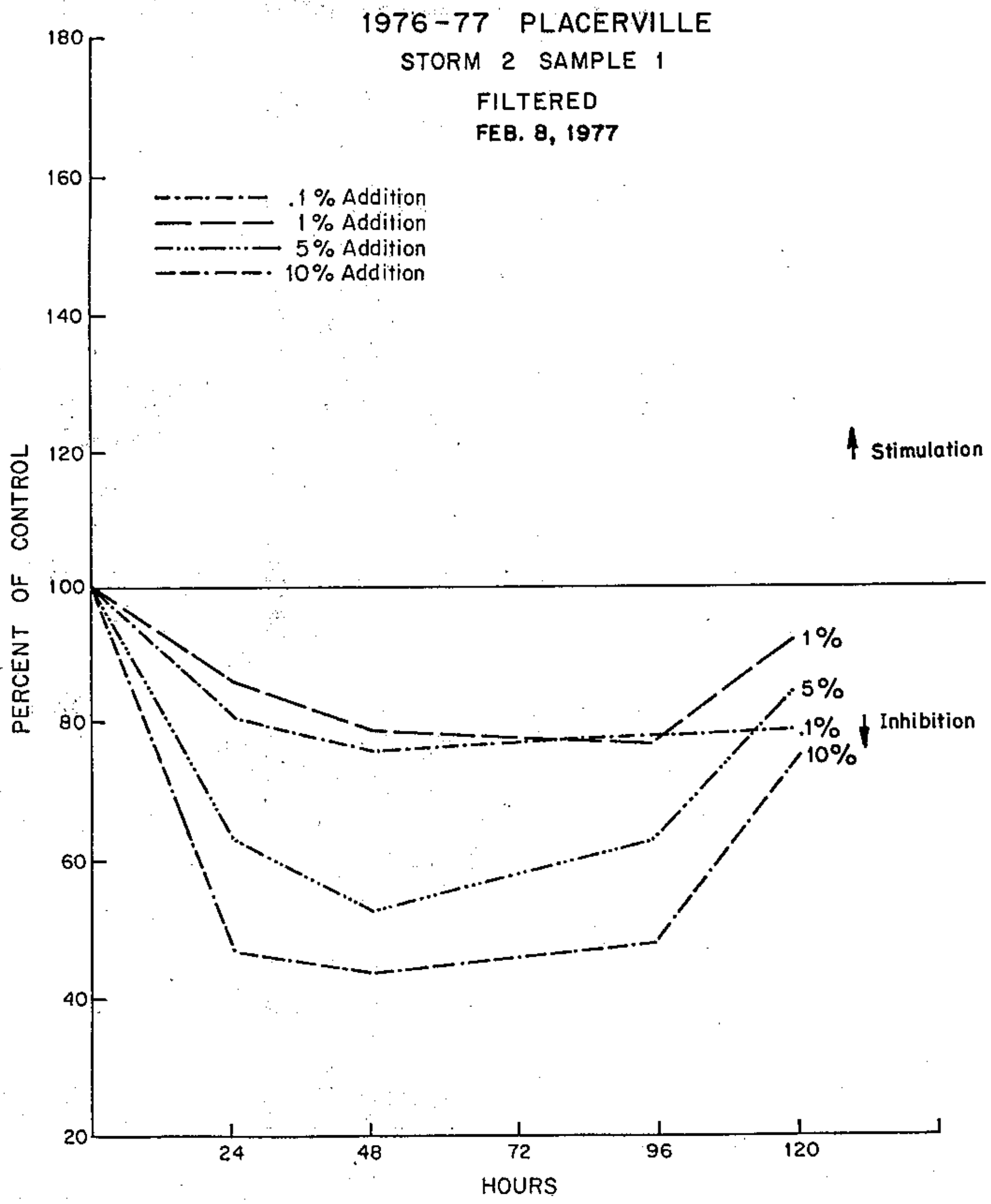
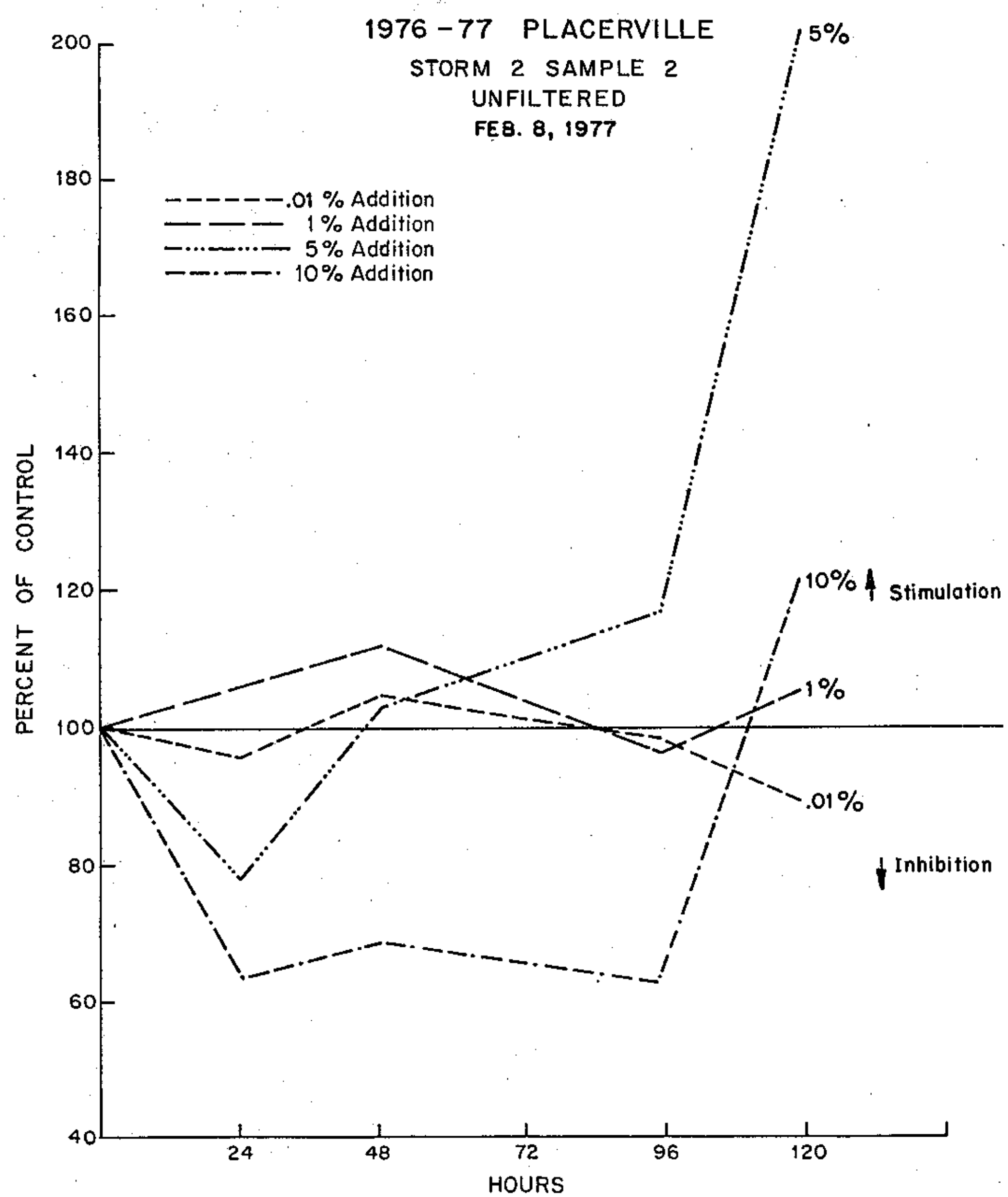

1976-77 PLACERVILLE
STORM 2 SAMPLE 1
FILTERED
FEB. 8, 1977
.1 % Addition
1 % Addition
5 % Addition
10 % Addition
Stimulation
Inhibition
1%
5%
.1%
10%
PERCENT OF CONTROL
180
160
140
120
100
80
60
40
20
24
48
72
96
120
HOURS

FIGURE 20



1976 - 77 PLACERVILLE
STORM 2 SAMPLE 2
UNFILTERED
FEB. 8, 1977
.01 % Addition
1 % Addition
5 % Addition
10 % Addition
PERCENT OF CONTROL
200
180
160
140
120
100
80
60
40
24
48
72
96
120
HOURS
5%
10%
1%
.01%
Stimulation
Inhibition

FIGURE 21

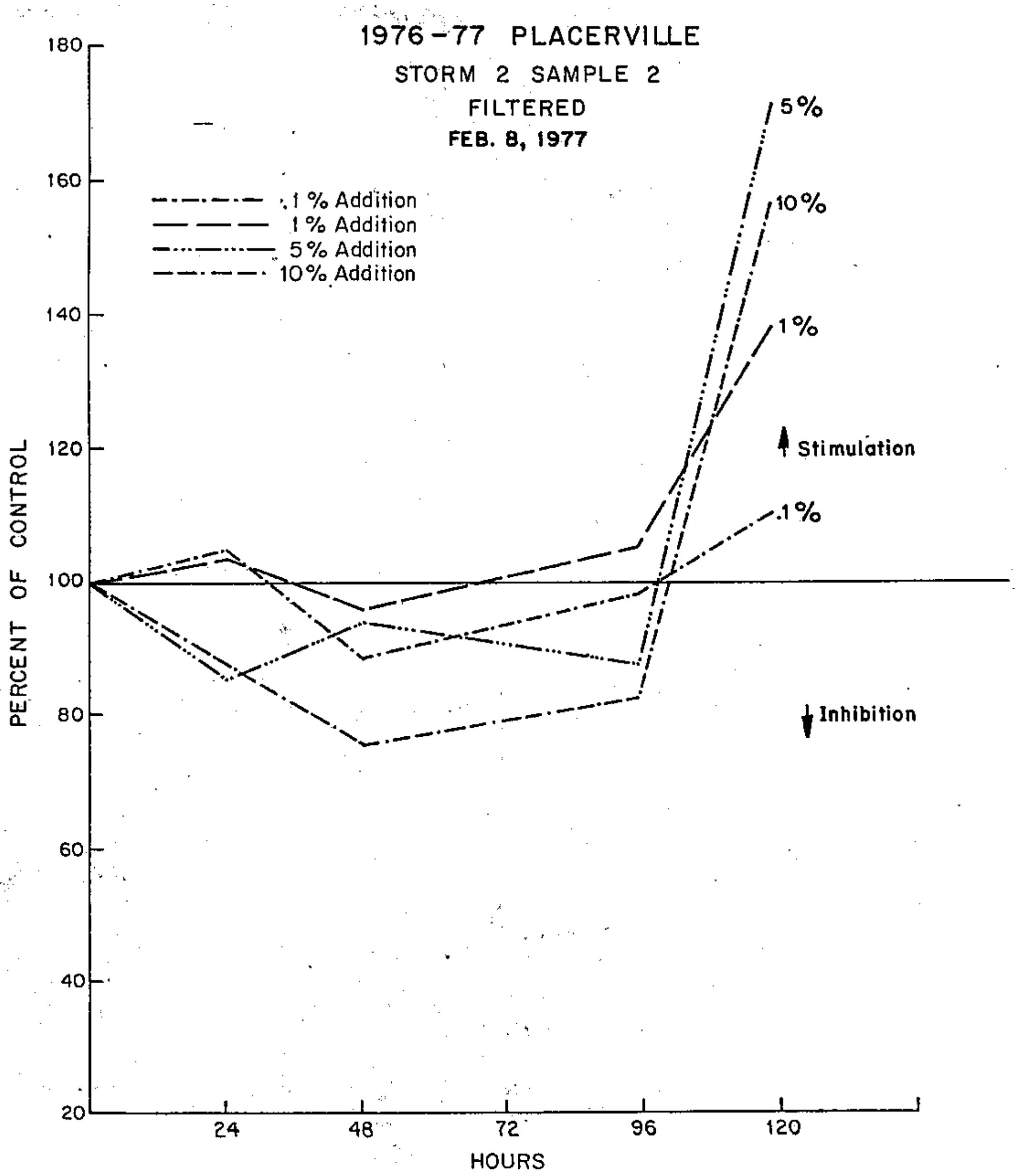
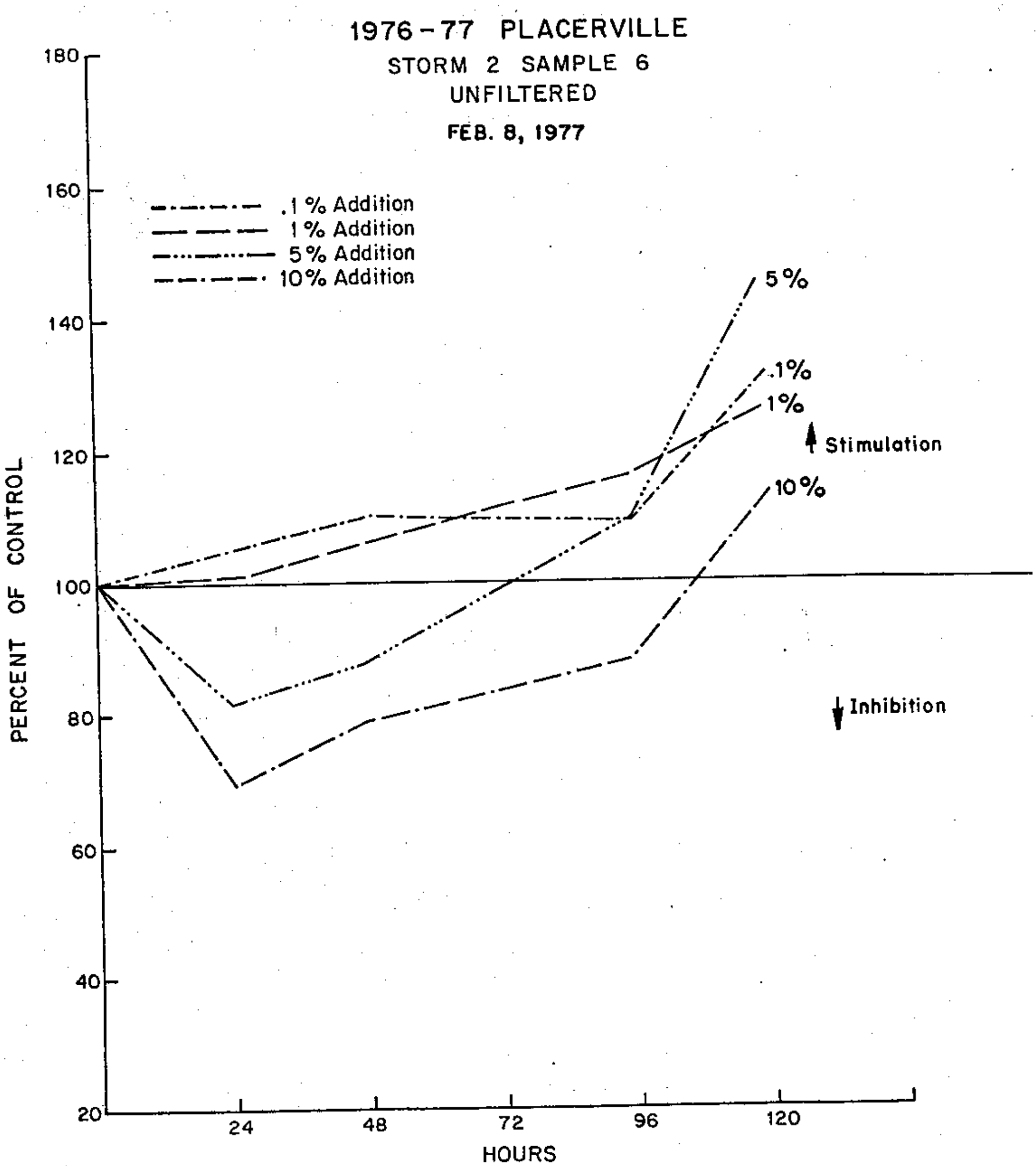

1976-77 PLACERVILLE
STORM 2 SAMPLE 2
FILTERED
FEB. 8, 1977
.1 % Addition
1 % Addition
5 % Addition
10 % Addition
5%
10%
1%
.1%
Stimulation
Inhibition
PERCENT OF CONTROL
180
160
140
120
100
80
60
40
20
24
48
72
96
120
HOURS

FIGURE 22



1976-77 PLACERVILLE
STORM 2 SAMPLE 6
UNFILTERED
FEB. 8, 1977
.1 % Addition
1 % Addition
5 % Addition
10% Addition
5%
.1%
1%
10%
Stimulation
Inhibition
PERCENT OF CONTROL
180
160
140
120
100
80
60
40
20
24
48
72
96
120
HOURS

FIGURE 23

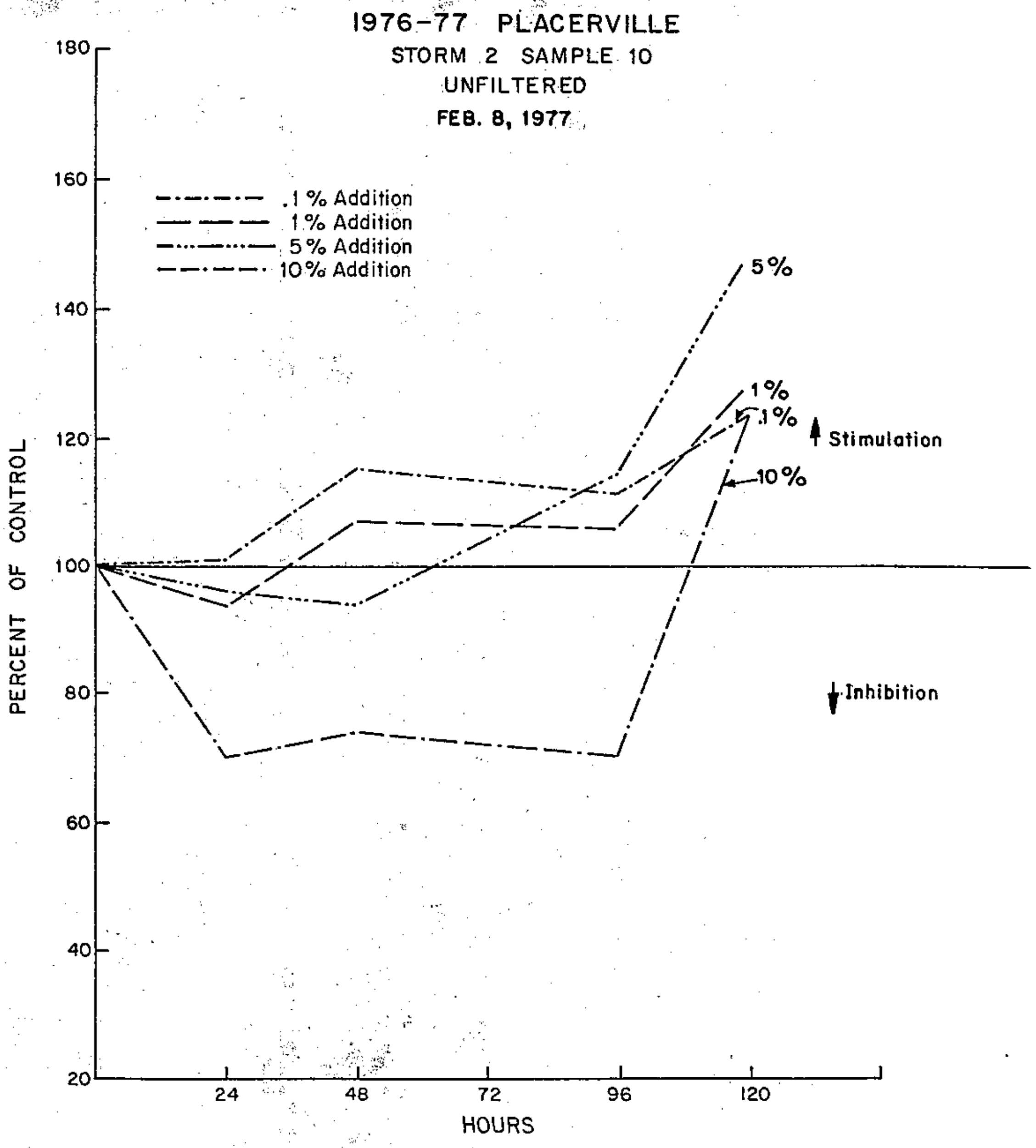

1976-77 PLACERVILLE
STORM 2 SAMPLE 10
UNFILTERED
FEB. 8, 1977
.1 % Addition
1 % Addition
5 % Addition
10% Addition
5%
1%
.1%
10%
Stimulation
Inhibition
PERCENT OF CONTROL
180
160
140
120
100
80
60
40
20
24
48
72
96
120
HOURS

FIGURE 24

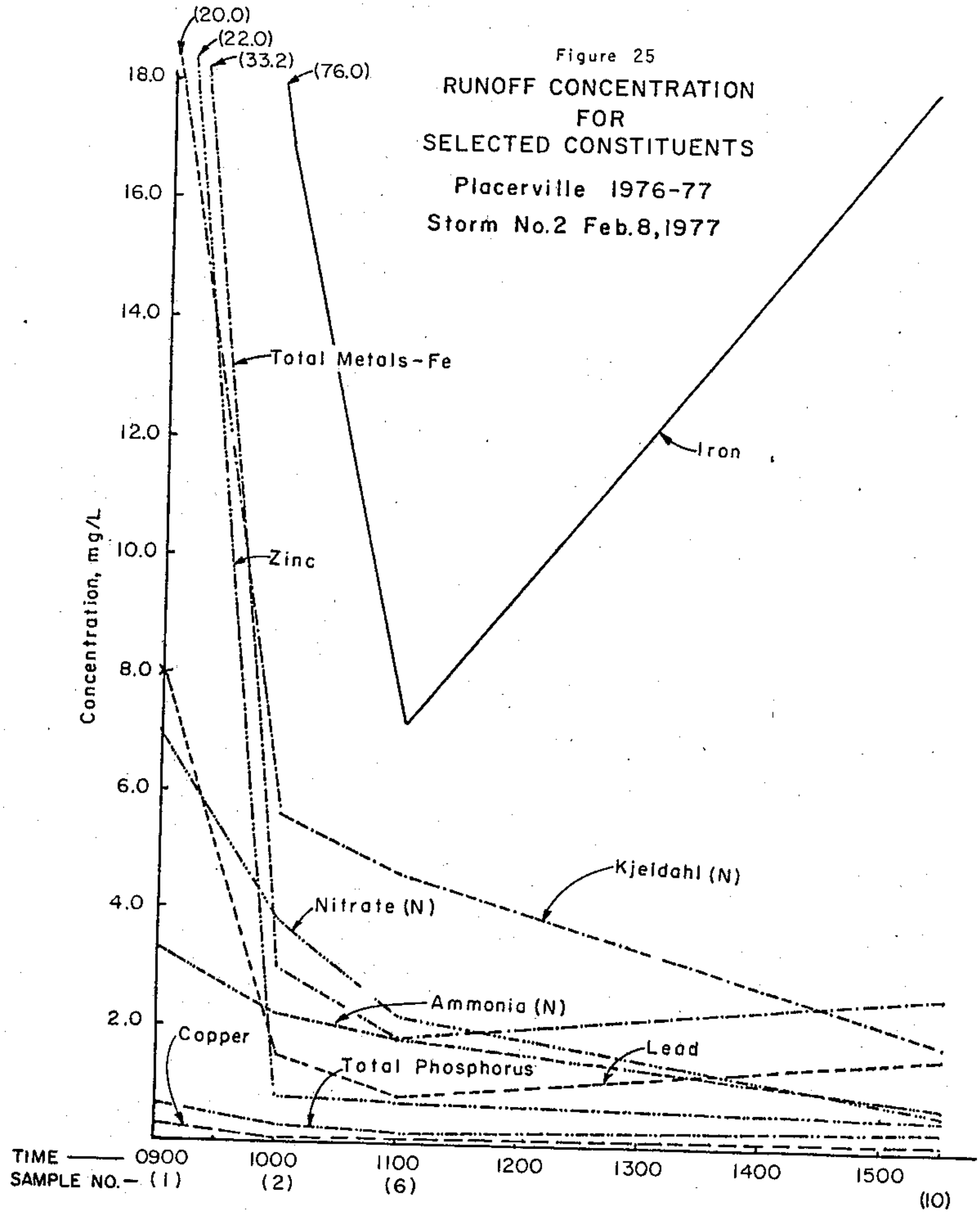


Figure 25
RUNOFF CONCENTRATION
FOR
SELECTED CONSTITUENTS
Placerville 1976-77
Storm No.2 Feb.8,1977
(20.0)
(22.0)
(33.2)
(76.0)
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
Concentration, mg/L
Total Metals-Fe
Iron
Zinc
Kjeldahl (N)
Nitrate (N)
Ammonia (N)
Lead
Copper
Total Phosphorus
TIME
SAMPLE NO.
0900
(1)
1000
(2)
1100
(6)
1200
1300
1400
1500
(10)

TABLE 4

Runoff Concentrations for Selected Chemical Constituents

Placerville 1976-77
Storm No. 2 February 8, 1977

	Concentration Mg/l			
Sample Number	1	2	6	10
METALS				
Iron (Fe)	76.0	17.0	7.2	19.0
Total Metals - Fe	33.2	3.0	1.8	2.5
Lead (Pb)	8.0	1.5	0.7	1.6
Zinc (Zn)	22.0	0.88	0.76	0.40
Copper (Cu)	0.32	0.06	0.04	0.04
NUTRIENTS				
Nitrate Nitrogen	7.0	3.8	2.2	0.35
Kjeldahl Nitrogen	20.0	5.6	4.7	1.9
Ammonia Nitrogen	3.3	2.2	1.8	0.4
Total Phosphorus	0.92	0.49	0.29	0.39
Ortho Phosphate	0.30	0.19	0.01	0.13
TOTAL	31.52	12.28	9.00	3.17

27 days after the previous rain at the site. Samples 1 and 2 were bioassayed as filtered and unfiltered while samples 6 and 10 were unfiltered. Sample 1 showed significant algal inhibition in the filtered and unfiltered assays at the 5% and 10% roadway runoff concentrations throughout the assay. Lower runoff concentrations were not significant. The total metals load of sample 1 was high (Table 4 and Figure 25) and may be responsible for the resultant inhibition.

Sample 2 filtered and nonfiltered, showed a response different from that of sample 1. With the exception of the 10% treatment, there were no significant differences between treatments and controls until day four (96 hours); at which time all treatments, with the exception of the 0.1% treatment, exhibited significant algal stimulation. There was a significant reduction in the concentration of many of the metals and nutrients from the road runoff samples (Figure 25 and Table 4) allowing the algae to assimilate materials and grow rapidly with time during the latter portion of the assay run.

Samples 6 and 10 (Figure 23-24), which were unfiltered, generally show an initial decrease in productivity in the higher percentage treatments and an upward surge of productivity during the latter period of test. The 10% treatment in samples 6 and 10 indicate problems, especially in sample 10, but by the 120 hour point the culture had recovered.

The algal response for the third storm (March 3, 1977) sampled at Placerville during the 1976-77 winter is shown in Figures 26-29. Figure 30 and Table 5 present the chemical

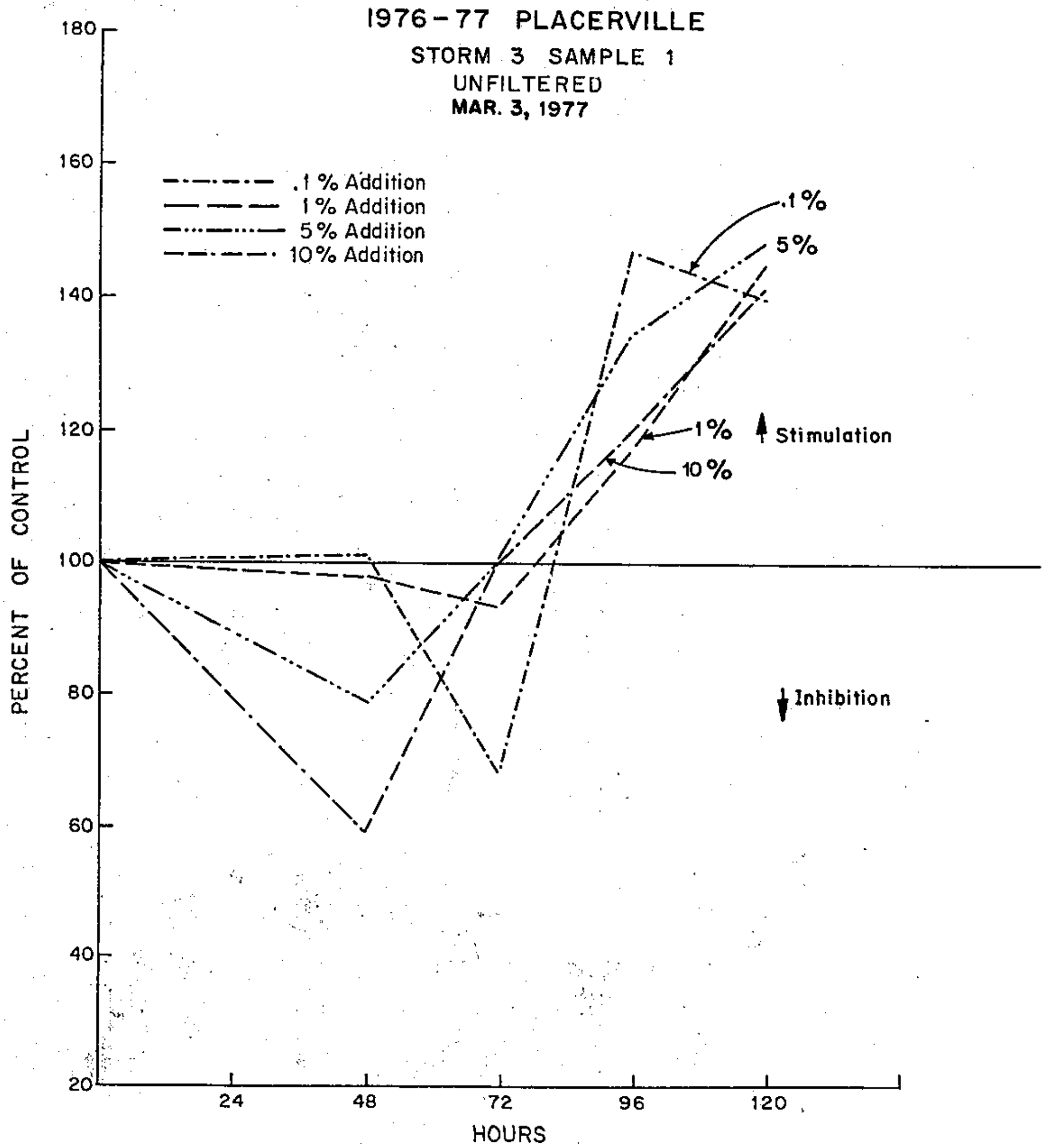

1976-77 PLACERVILLE
STORM 3 SAMPLE 1
UNFILTERED
MAR. 3, 1977
.1 % Addition
1 % Addition
5 % Addition
10 % Addition
.1 %
5 %
1 %
10 %
Stimulation
Inhibition
PERCENT OF CONTROL
180
160
140
120
100
80
60
40
20
24
48
72
96
120
HOURS

FIGURE 26

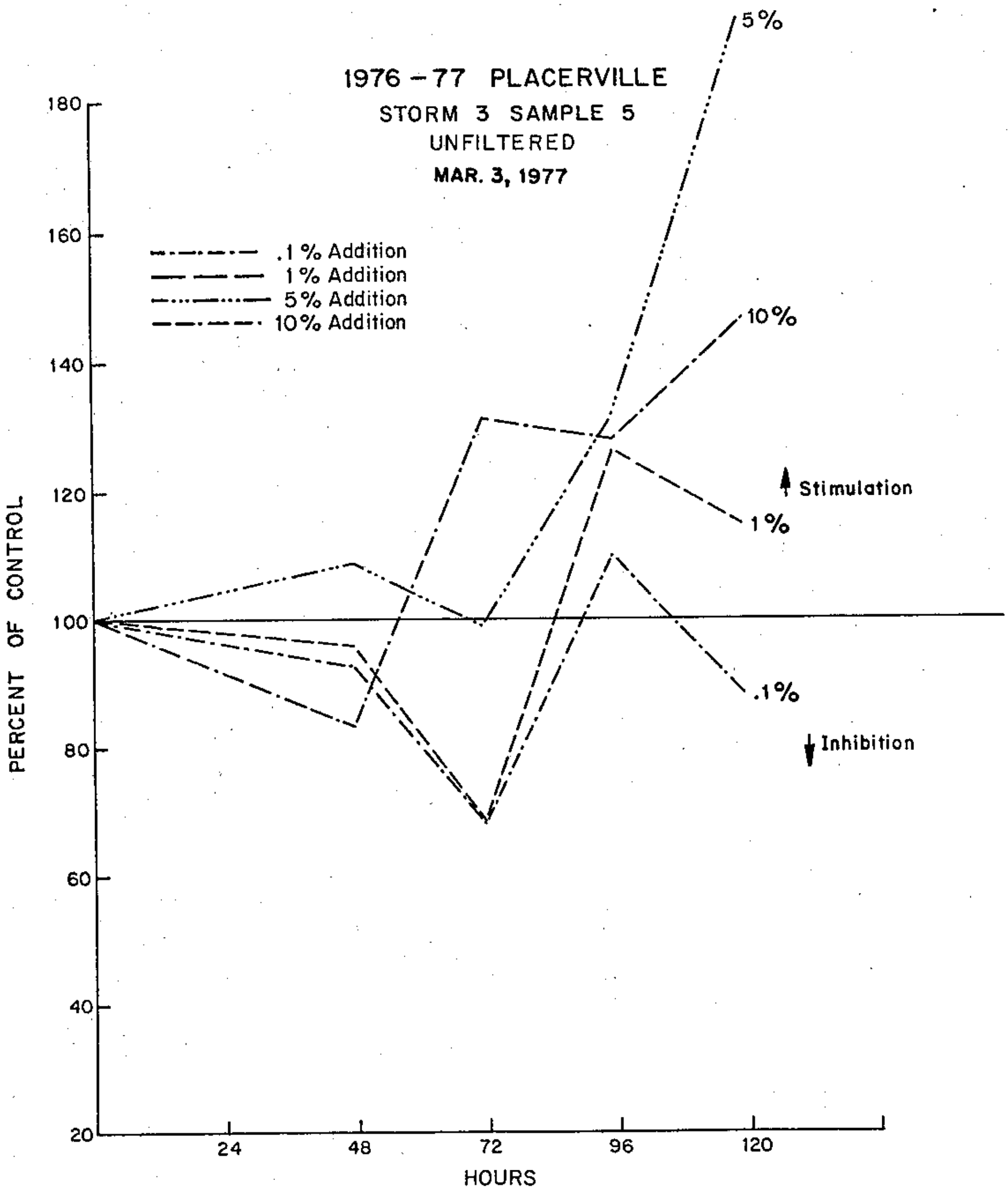

1976 – 77 PLACERVILLE
STORM 3 SAMPLE 5
UNFILTERED
MAR. 3, 1977
.1 % Addition
1 % Addition
5% Addition
10% Addition
5%
10%
1%
.1%
Stimulation
Inhibition
PERCENT OF CONTROL
180
160
140
120
100
80
60
40
20
24
48
72
96
120
HOURS

FIGURE 27

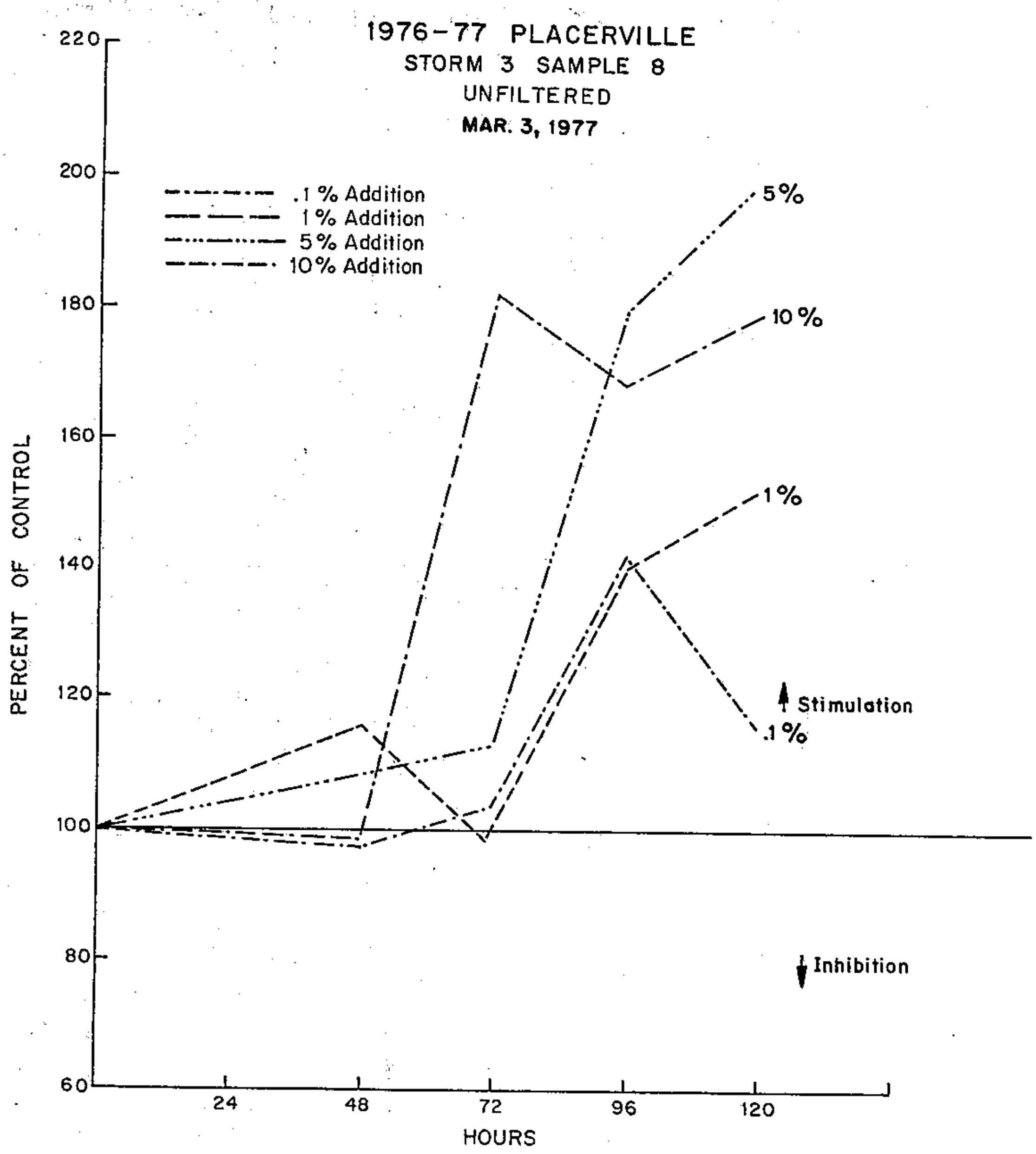

1976-77 PLACERVILLE
STORM 3 SAMPLE 8
UNFILTERED
MAR. 3, 1977
.1 % Addition
1 % Addition
5 % Addition
10% Addition
5%
10 %
1%
.1%
Stimulation
Inhibition
PERCENT OF CONTROL
220
200
180
160
140
120
100
80
60
24
48
72
96
120
HOURS

FIGURE 28

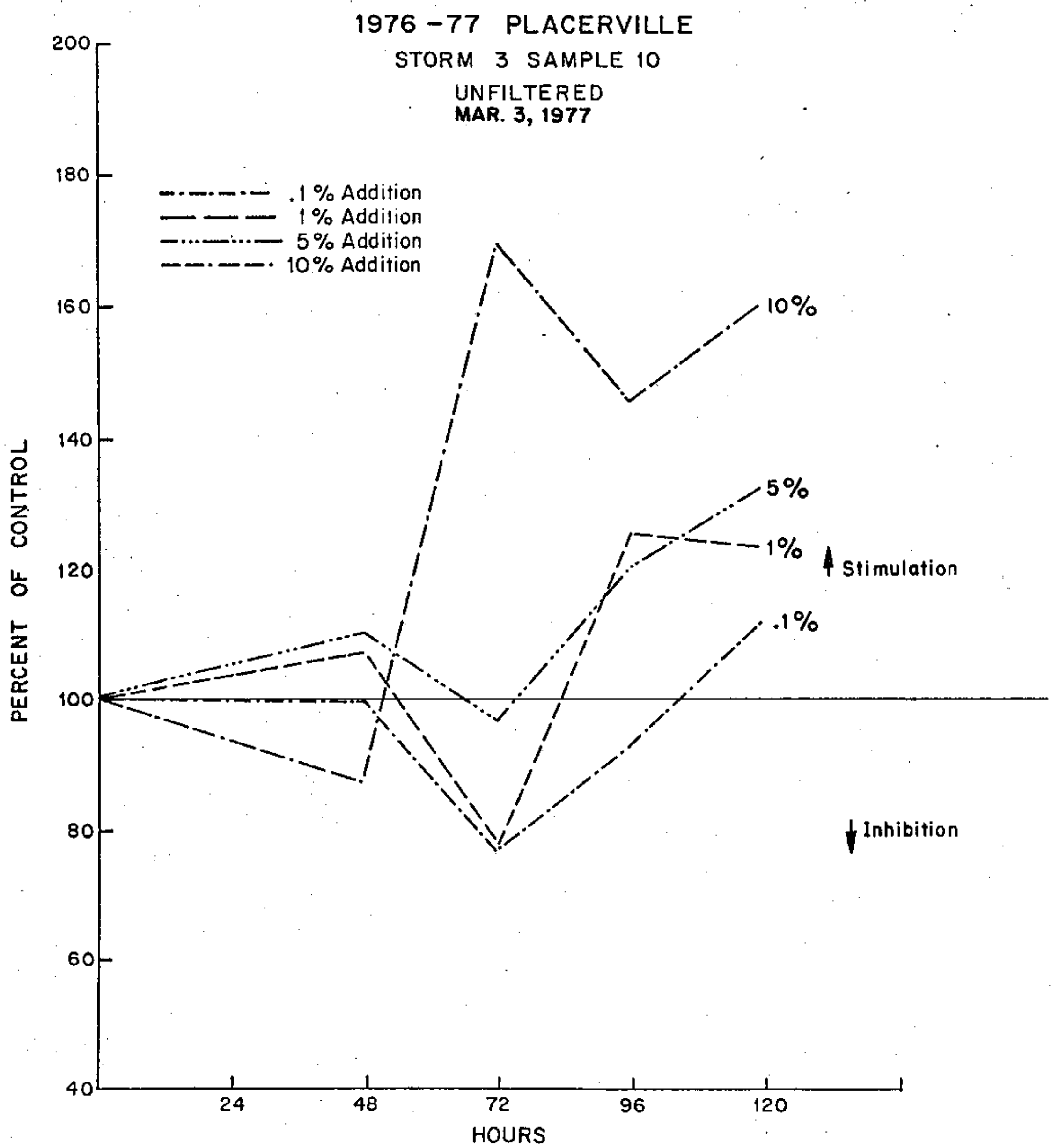

1976 -77 PLACERVILLE
STORM 3 SAMPLE 10
UNFILTERED
MAR. 3, 1977
.1 % Addition
1 % Addition
5 % Addition
10 % Addition
10%
5%
1%
.1%
Stimulation
Inhibition
PERCENT OF CONTROL
200
180
160
140
120
100
80
60
40
24
48
72
96
120
HOURS

FIGURE 29

Figure 30

RUNOFF CONCENTRATION
FOR
SELECTED CONSTITUENTS

Placerville 1976-77

Storm No. 3 March 3, 1977

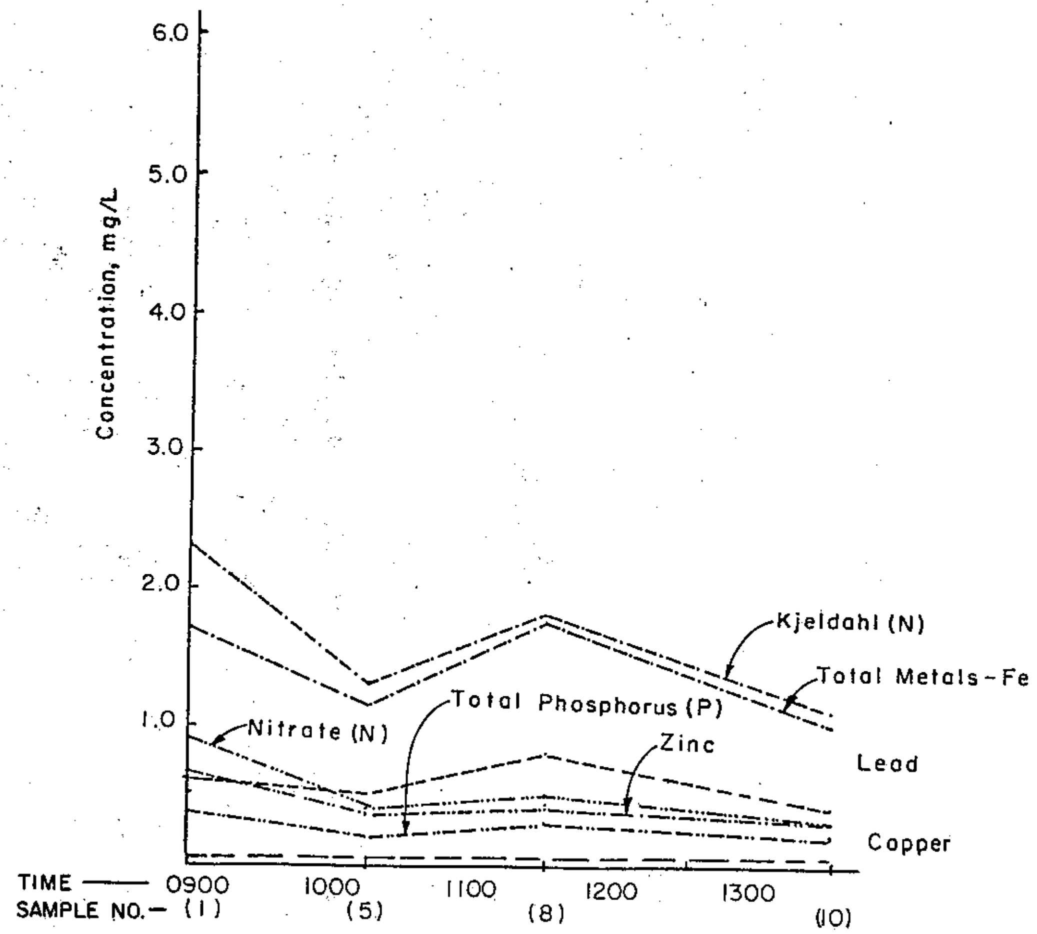


TABLE 5

Runoff Concentrations for Selected Chemical Constituents

Placerville 1976-77
Storm No. 3 March 3, 1977

	Concentration Mg/l			
Sample Number	1	5	8	10
METALS				
Iron (Fe)	13.0	13.0	19.0	8.9
Total Metals - Fe	1.75	1.26	1.76	1.01
Lead (Pb)	0.6	0.5	0.8	0.4
Zinc (Zn)	0.68	0.36	0.40	0.28
Copper (Cu)	0.06	0.04	0.05	0.03
NUTRIENTS				
Nitrate Nitrogen	0.9	0.4	0.4	0.7
Kjeldahl Nitrogen	2.3	1.3	1.9	1.1
Ammonia Nitrogen	0.5	0.4	0.5	0.3
Total Phosphorus	0.36	0.23	0.29	0.17
Ortho Phosphate	0.06	0.05	0.05	0.05
TOTAL	4.12	2.38	3.14	2.32

analyses of selected runoff constituents from the samples assayed. Four samples from this storm were tested using unfiltered runoff. The short time between this storm and the previous event (three days) for contaminants to accumulate on the highway surfaces probably account for the relatively low contaminant levels (Figure 30 and Table 5). The total metals minus iron for the four samples ranged from 1.01 to 1.75 mg/litre. No inhibition of algal response was indicated.

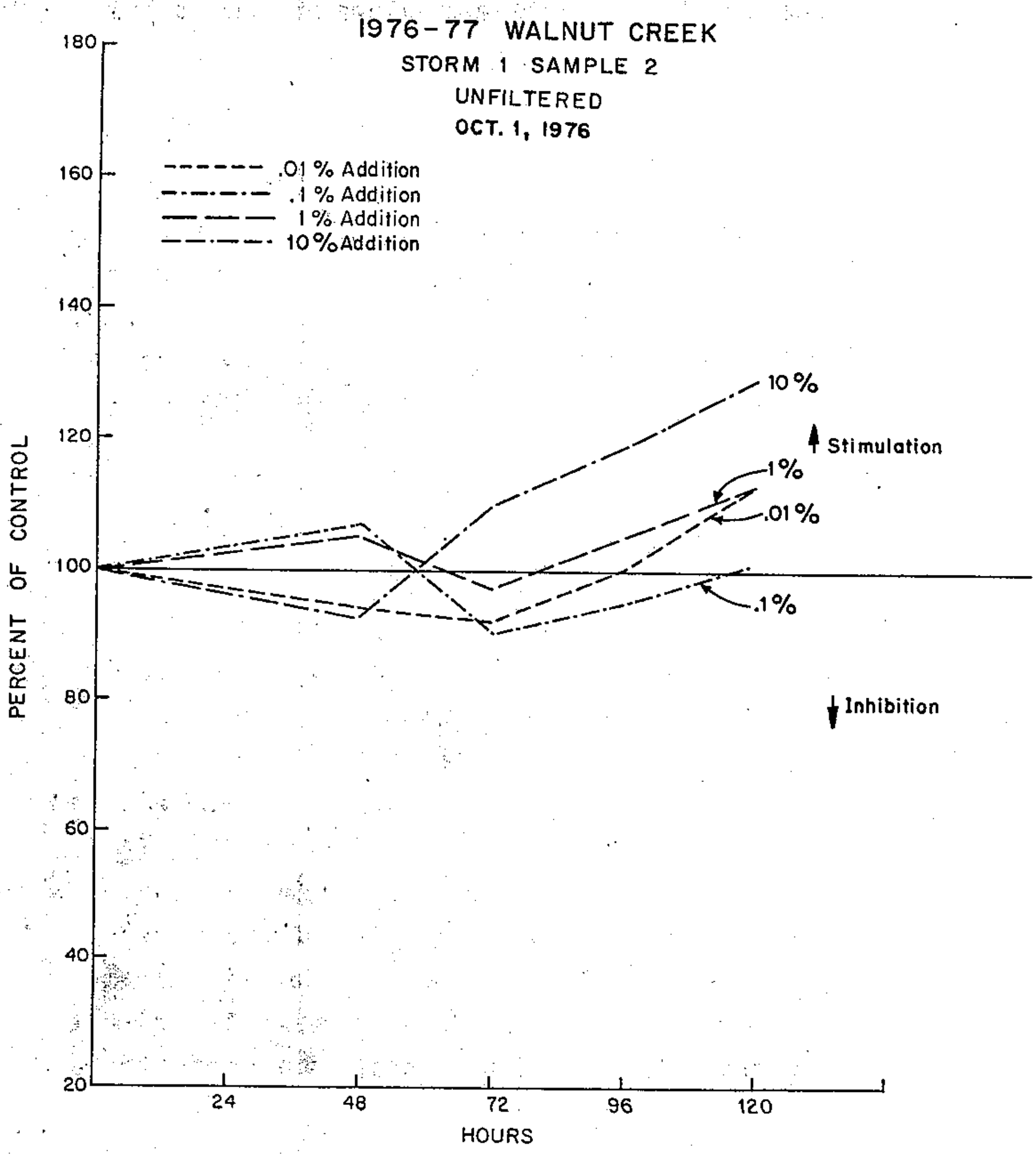
The assay for sample 1 showed an initial inhibition with the 10% treatment while the other treatments were not significantly different from the controls. After the third day (72 hours) all treatments showed an accelerated algal response. By the 96 and 120 hour interval, samples displayed significant stimulation. Sample 5 (Figure 27) indicates a very significant stimulation at the 5% treatment level while the 10% was less significant. In this assay the lower treatment levels did not alter the algal response. The levels of runoff materials which were significant in the higher treatment levels were not sufficient in the smaller dilutions to effect significant algal response. Sample 8 of storm 3 (Figure 28) indicated significant algal growth stimulation at the higher treatments and slightly elevated responses at the lower levels. Sample 10 showed (Figure 29) the same general response as the previous samples, though a slightly lower response at most of the treatment levels. As noted in Table 5, there was a slight general decrease in runoff contaminant levels from sample 1 through 10 as the storm progressed.

For all Placerville storms, analysis of variance indicated that concentration of runoff interaction, time interaction within the sample and total combined interactions were significant between treatments and between controls and treatments.

Walnut Creek

The first storm sampled at Walnut Creek (October 1, 1976) during the 1976-77 winter was 3 days after previous wet weather. Bioassay results for the three samples tested are shown in Figures 31-33. Chemical test data are presented in Figure 34 and Table 6 with the full chemical analysis shown in Appendix A.

The sample 2 bioassay showed no significant variation from the untreated controls except for a slight stimulation in the lower runoff treatment levels during the final sub-sample period. Sample 3 exhibited the same general response as sample 2 with the exception of a substantially elevated response with the 10% treatment. The fourth runoff sample showed a slight stimulation at all levels, and significant stimulation at the 1% and 10% levels. A 5% treatment was not used in this assay. Chemical analyses did not indicate an explaination for the differences between the slight response of sample 2 and the greater responses of samples 3 and 4. The analysis of variance does show significant differences in the concentration interaction within samples, between treatments and between treatments and controls while showing no significant differences in either case with the combined interaction of time, sample and concentration.



1976-77 WALNUT CREEK
STORM 1 SAMPLE 2
UNFILTERED
OCT. 1, 1976
.01 % Addition
.1 % Addition
1 % Addition
10 % Addition
10 %
1 %
.01 %
.1 %
Stimulation
Inhibition
PERCENT OF CONTROL
180
160
140
120
100
80
60
40
20
24
48
72
96
120
HOURS

FIGURE 31

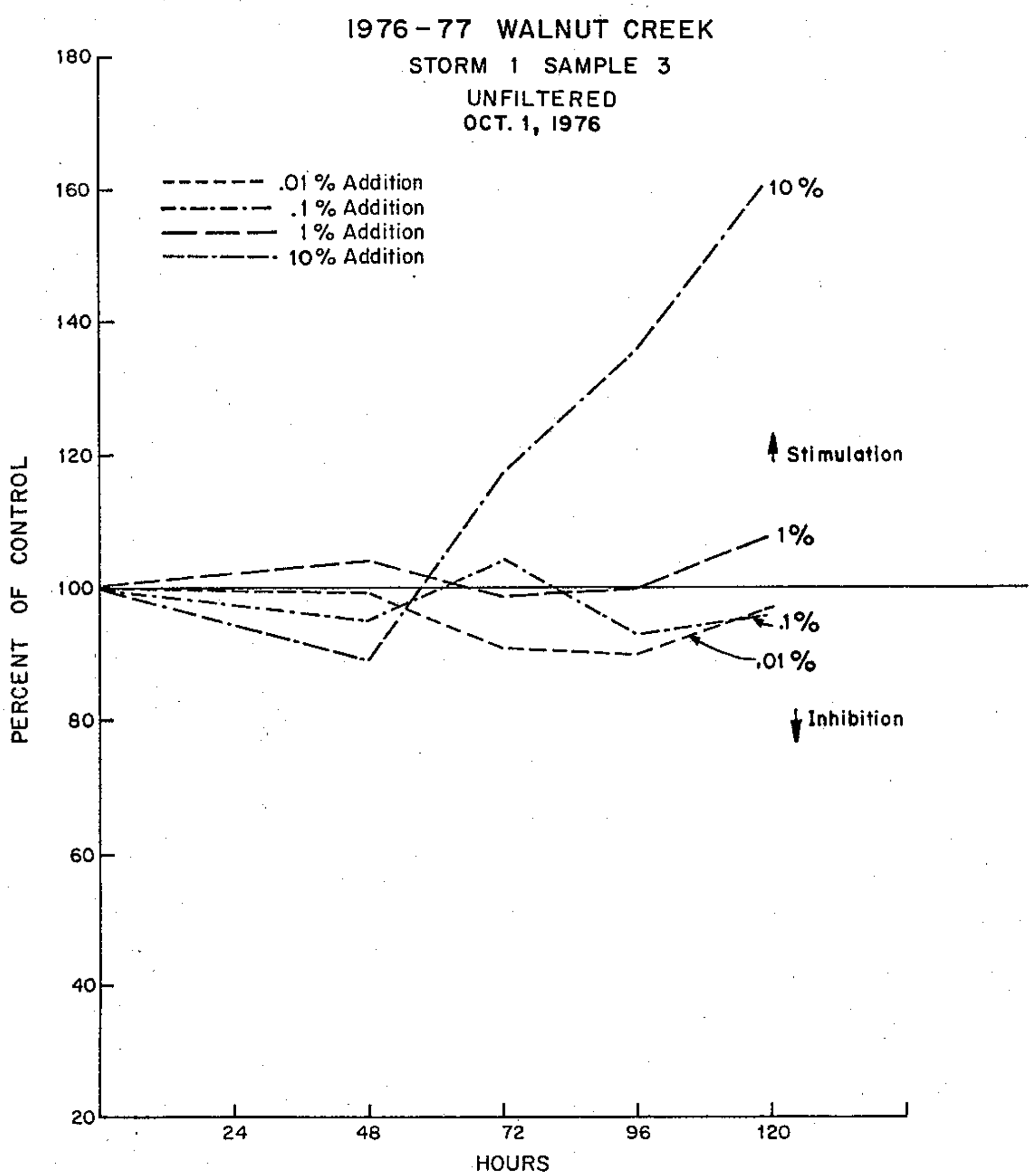

1976-77 WALNUT CREEK
STORM 1 SAMPLE 3
UNFILTERED
OCT. 1, 1976
.01 % Addition
.1 % Addition
1 % Addition
10% Addition
10%
Stimulation
1%
.1%
.01%
Inhibition
PERCENT OF CONTROL
180
160
140
120
100
80
60
40
20
24
48
72
96
120
HOURS

FIGURE 32

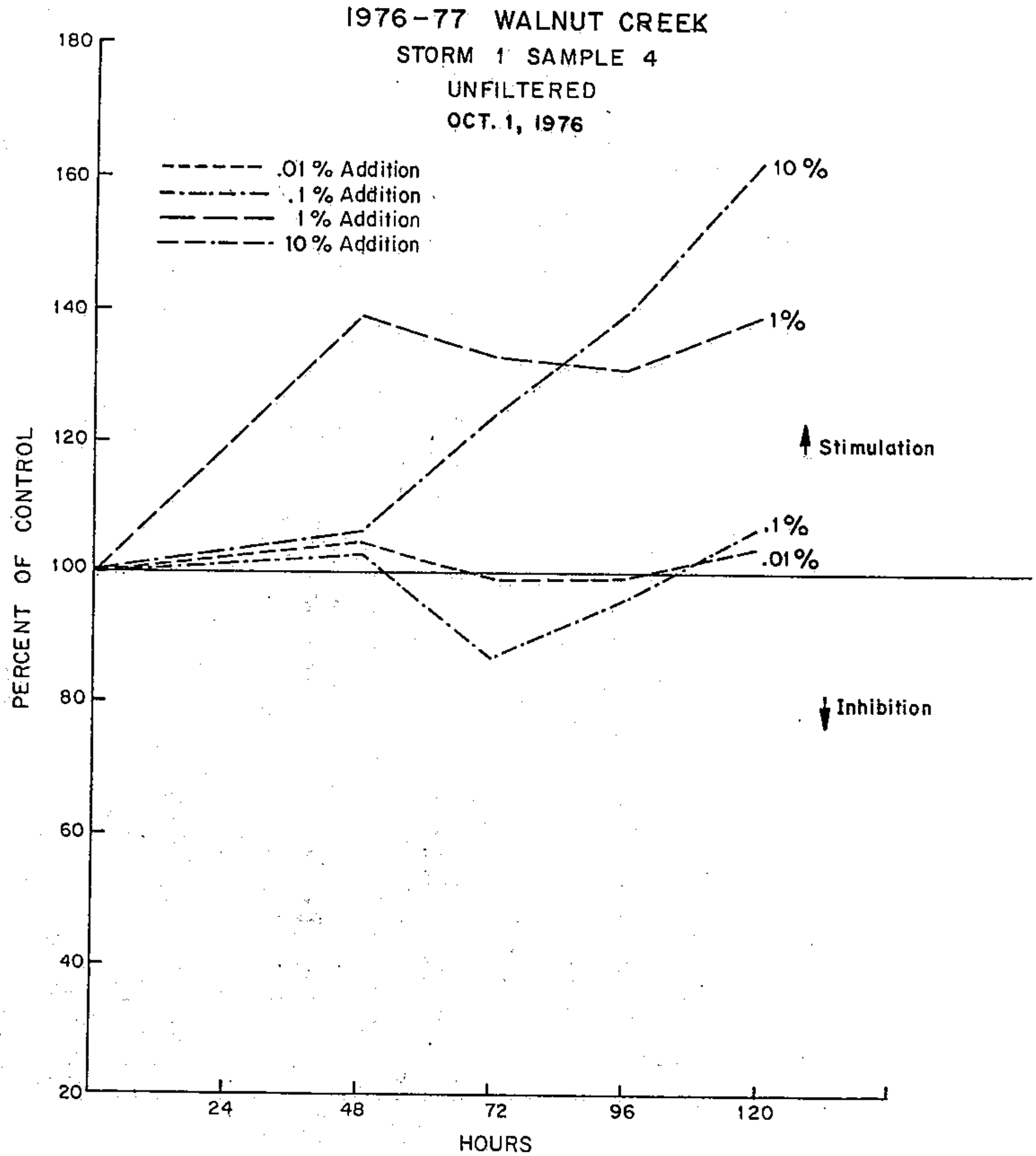

1976-77 WALNUT CREEK
STORM 1 SAMPLE 4
UNFILTERED
OCT. 1, 1976
.01 % Addition
.1 % Addition
1 % Addition
10 % Addition
10 %
1%
.1%
.01%
Stimulation
Inhibition
PERCENT OF CONTROL
180
160
140
120
100
80
60
40
20
24
48
72
96
120
HOURS

FIGURE 33

Figure 34

RUNOFF CONCENTRATION FOR SELECTED CONSTITUENTS

Walnut Creek 1976-77

Storm No. 1 Oct. 1, 1976

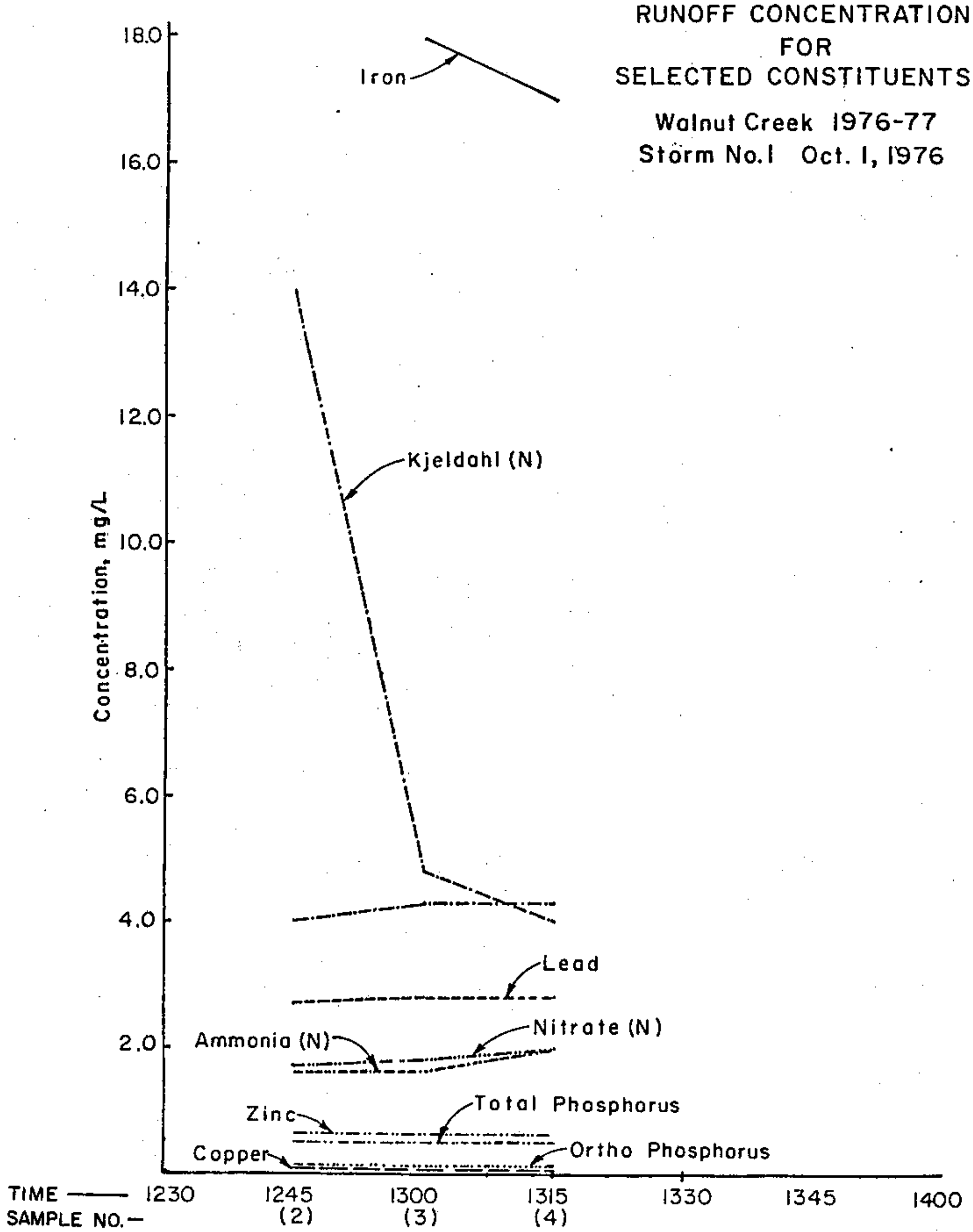


TABLE 6

Runoff Concentrations for Selected Chemical Constituents

Walnut Creek 1976-77
Storm No. 1 October 1, 1976

	Concentration Mg/l		
Sample Number	2	3	4
METALS			
Iron (Fe)	21.0	18.0	17.0
Total Metals - Fe	4.05	4.18	4.16
Lead (Pb)	2.7	2.8	2.8
Zinc (Zn)	0.64	0.72	0.72
Copper (Cu)	0.12	0.12	0.13
NUTRIENTS			
Nitrate Nitrogen	1.7	1.8	2.0
Kjeldahl Nitrogen	14.0	4.8	4.0
Ammonia Nitrogen	1.6	1.7	2.0
Total Phosphorus	0.57	0.53	0.53
Ortho Phosphate	0.12	0.13	0.11
TOTAL	17.99	8.96	8.64

The chemical analysis of selected metals and nutrients (Figure 34 and Table 6) shows a general reduction in concnetration runoff pollutants as the storm progressed. Even with the lowered metal content of the latter samples, the bioassays indicated that the higher treatment (10%) seriously inhibited algal response. This indicated that tolerance levels for the algal populations were exceeded at increased levels of pavement runoff.

The third storm (December 30, 1976) sampled at the Walnut Creek site occurred approximately 45 days after prior precipitation. Four unfiltered samples were bioassayed. Bioassay results are presented graphically in Figure 35 to 38. Figure 39 and Table 7 delineate the chemical analysis of particular parameters noted in previous discussions. A full chemical analysis is shown in Appendix A.

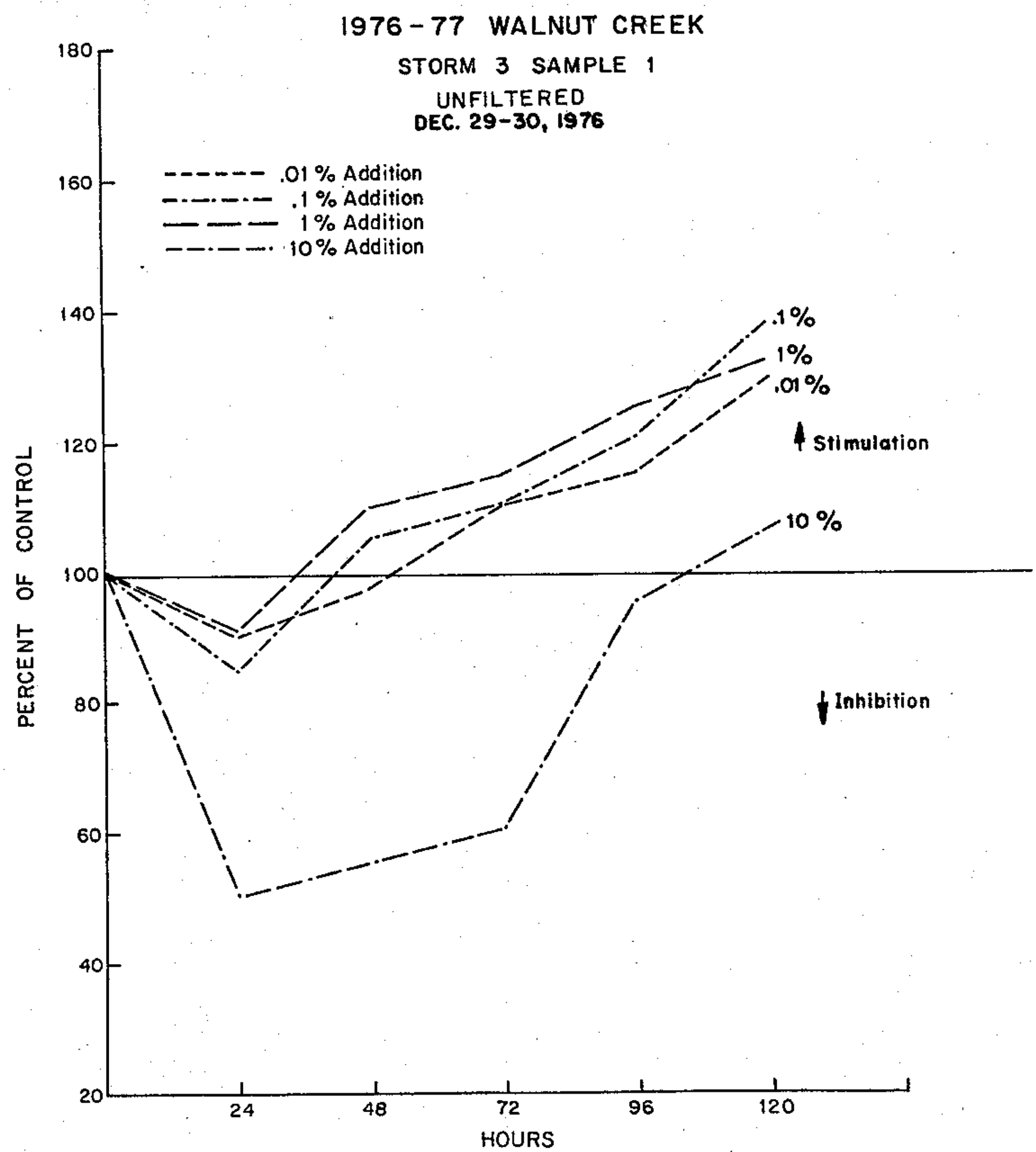
Sample 1 showed a significant algal inhibition at the 10% treatment level during the 24 hr. 48 hr and 72 hr subsampling periods. It returned to parity with the control during the latter part of the assay. The lower runoff treatment levels remained within the control response levels with a slight stimulation toward the latter subsample period. The general trend of the roadway runoff sample was a slight stimulation of the algal bioassay cultures.

Sample 3 results were similar to sample 1. Again, the 10% treatment was initially inhibitory, but the culture returned to normal levels by the end of the test run. The metals present in sample 3 were approximately one-half of those in sample 2 and may be responsible for the decreased inhibition shown in the 10% treatment.

Sample 8 exhibited the same trend of the previous bioassays. There was initial inhibition in the 10% treatment; however, sample 8 responded quicker in moving toward the control condition. Additionally, this bioassay was somewhat stimulatory at the end, similar in magnitude to the previous bioassay.

Sample 15 indicated a faster rise in stimulation at all levels of treatment after an initial slight inhibitory period (except the 10% treatment, which is significantly inhibitory). All levels of treatment maintained a stimulary posture throughout the bioassay except the .1% and 1% additions, which tended to return to control levels during the latter portion of the test.

The analysis of variance (Appendix B) for the third Walnut Creek storm (December 29-30, 1976) shows that concentration, time, concentration within time interaction, concentration within sample interaction, time within sample interaction and the combined interactions were all significant. In most cases, between treatments and between treatments and the controls were also significant.



1976-77 WALNUT CREEK
STORM 3 SAMPLE 1
UNFILTERED
DEC. 29-30, 1976
.01 % Addition
.1 % Addition
1 % Addition
10 % Addition
.1%
1%
.01%
Stimulation
10 %
Inhibition
PERCENT OF CONTROL
180
160
140
120
100
80
60
40
20
24
48
72
96
120
HOURS

FIGURE 35

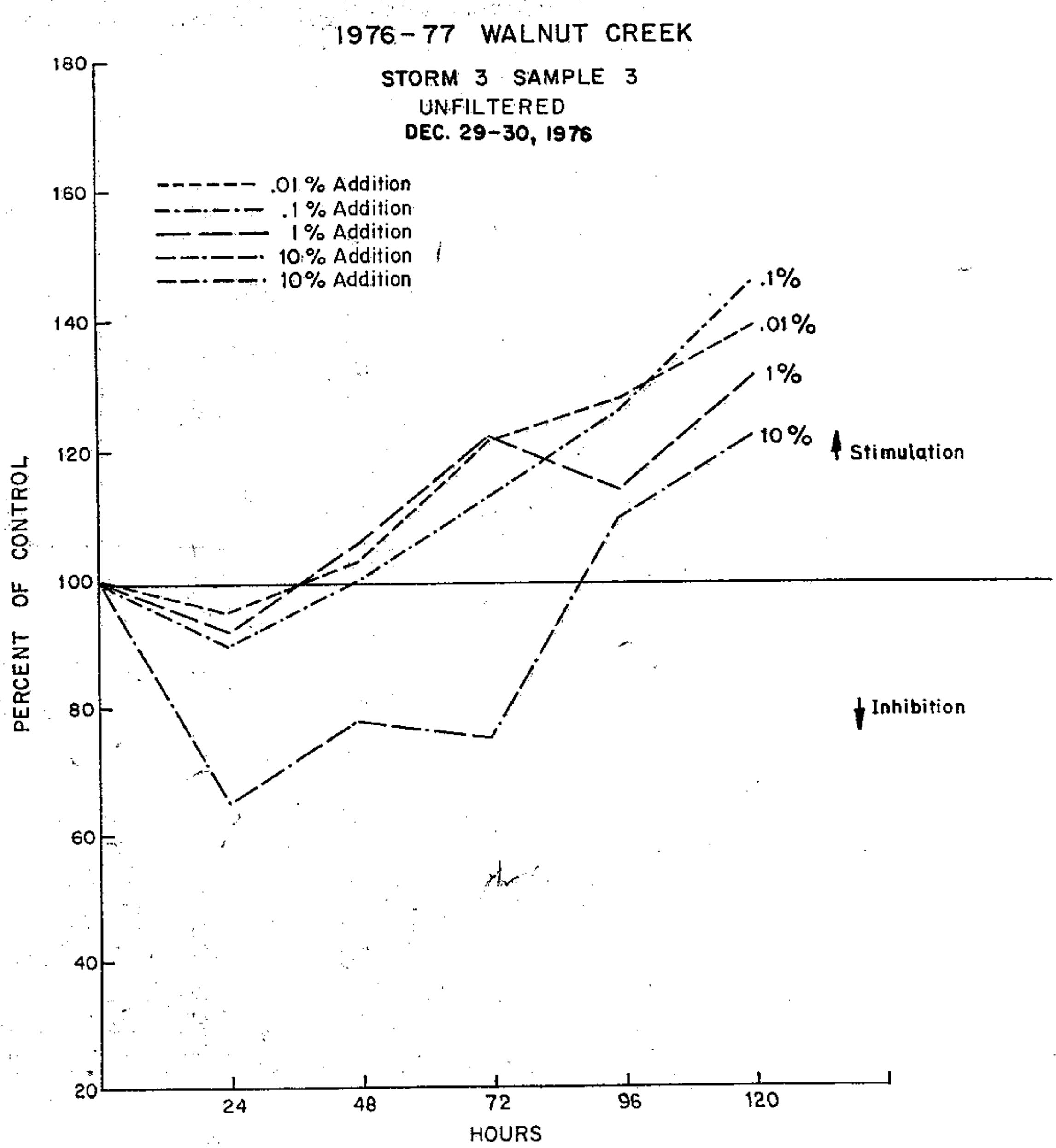

1976-77 WALNUT CREEK
STORM 3 SAMPLE 3
UNFILTERED
DEC. 29-30, 1976
.01 % Addition
.1 % Addition
1 % Addition
10 % Addition
10% Addition
.1%
.01%
1%
10%
Stimulation
Inhibition
PERCENT OF CONTROL
180
160
140
120
100
80
60
40
20
24
48
72
96
120
HOURS

FIGURE 36

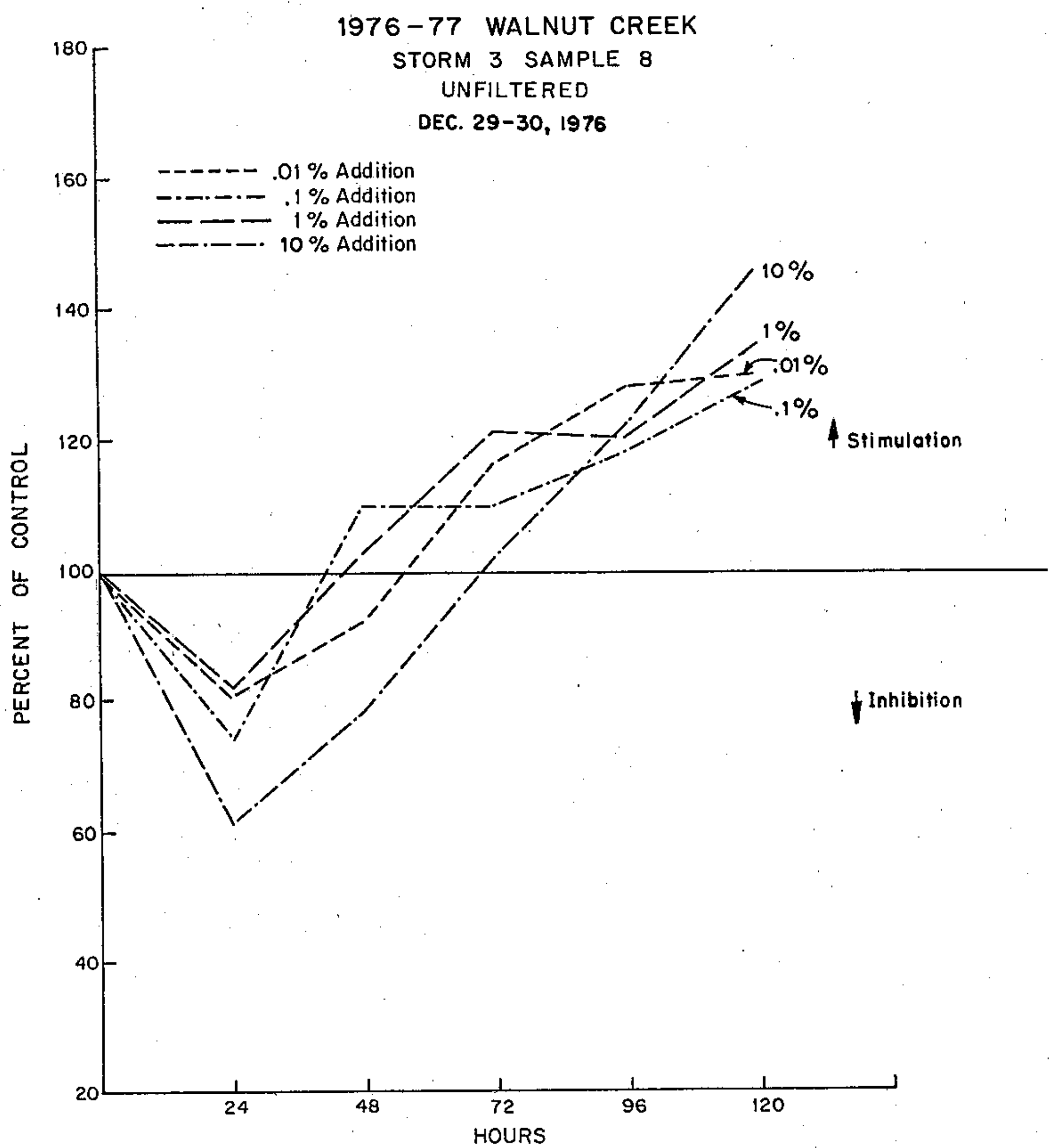

1976-77 WALNUT CREEK
STORM 3 SAMPLE 8
UNFILTERED
DEC. 29-30, 1976
.01 % Addition
.1 % Addition
1 % Addition
10 % Addition
10%
1%
.01%
.1%
Stimulation
Inhibition
PERCENT OF CONTROL
HOURS
180
160
140
120
100
80
60
40
20
24
48
72
96
120

FIGURE 37

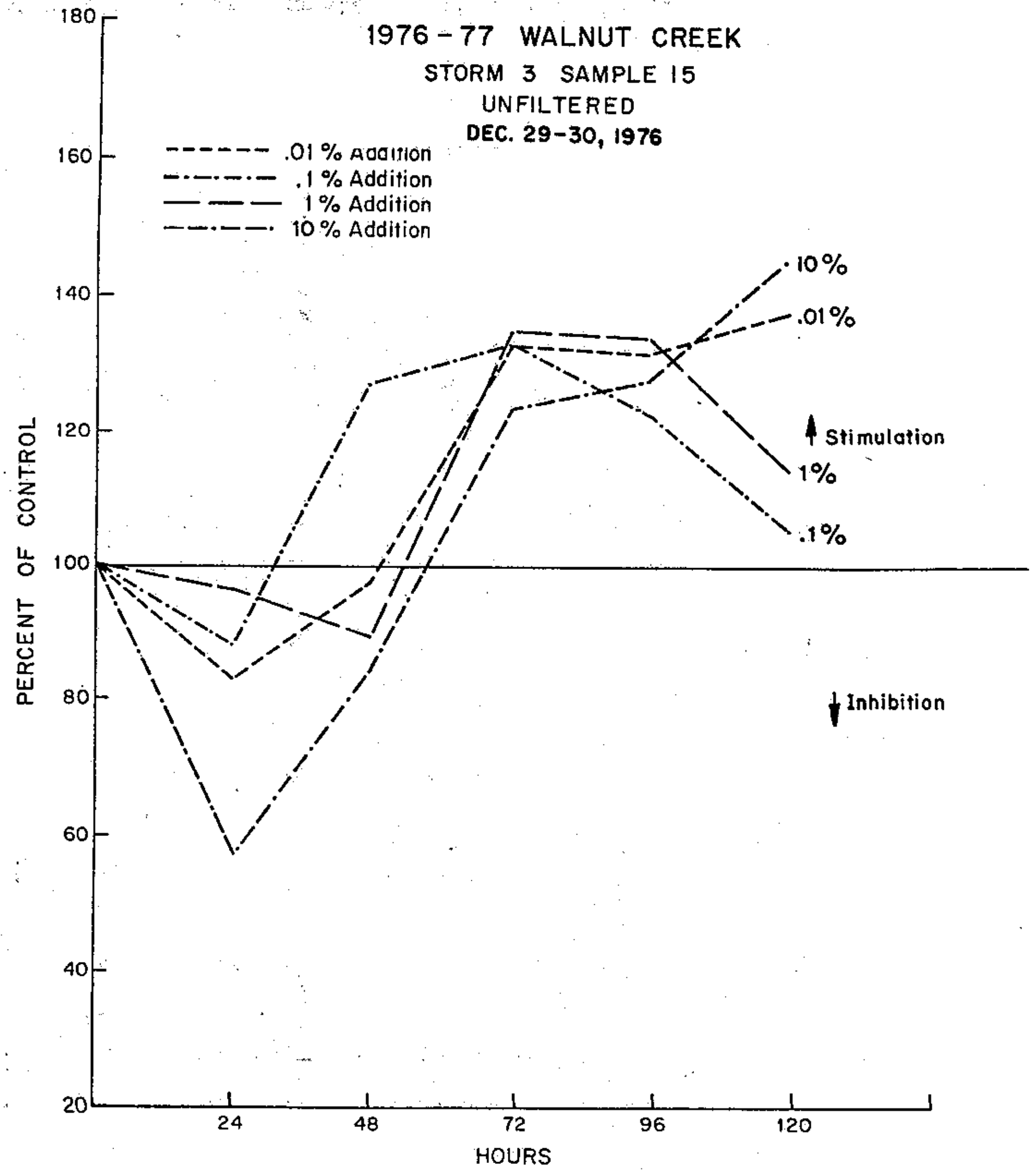

1976 - 77 WALNUT CREEK
STORM 3 SAMPLE 15
UNFILTERED
DEC. 29-30, 1976
.01 % Addition
.1 % Addition
1 % Addition
10 % Addition
10%
.01%
Stimulation
1%
.1%
Inhibition
PERCENT OF CONTROL
180
160
140
120
100
80
60
40
20
24
48
72
96
120
HOURS

FIGURE 38

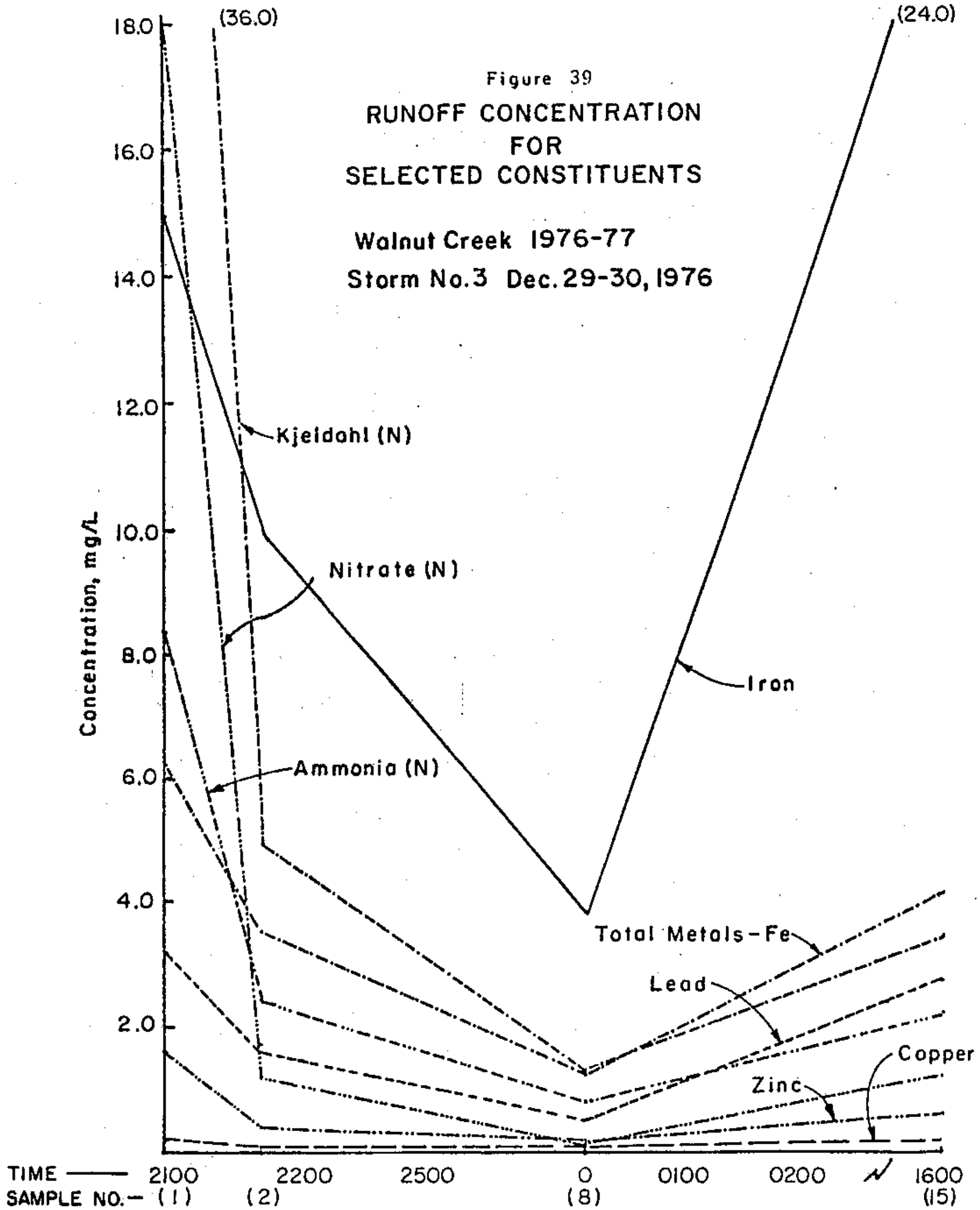


Figure 39
RUNOFF CONCENTRATION
FOR
SELECTED CONSTITUENTS
Walnut Creek 1976-77
Storm No.3 Dec. 29-30, 1976
(36.0)
(24.0)
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
Concentration, mg/L
Kjeldahl (N)
Nitrate (N)
Ammonia (N)
Iron
Total Metals - Fe
Lead
Copper
Zinc
TIME
2100
2200
2500
0
0100
0200
1600
SAMPLE NO.
(1)
(2)
(8)
(15)

TABLE 7

Runoff Concentrations for Selected Chemical Constituents

Walnut Creek 1976-77
Storm No. 3 Dec. 29-30, 1976

	Concentration Mg/l			
Sample Number	1	3	8	15
METALS				
Iron (Fe)	15.0	10.0	3.8	24.0
Total Metals - Fe	6.28	3.59	1.07	4.15
Lead (Pb)	3.2	1.7	0.7	2.7
Zinc (Zn)	1.64	0.40	0.16	0.64
Copper (Cu)	0.23	0.08	0.04	0.13
NUTRIENTS				
Nitrate Nitrogen	18.0	1.2	0.35	1.3
Kjeldahl Nitrogen	36.0	5.0	1.3	3.5
Ammonia Nitrogen	8.4	2.4	0.8	2.2
Total Phosphorus	1.39	0.32	0.13	0.58
Ortho Phosphate	0.81	0.12	0.06	0.10
TOTAL	64.60	9.04	2.64	7.68

The 1977-78 winter marked a return to wetter weather in California after two years of drought. The highways underwent considerably more flushing and cleaning by rainfall than during the two previous winters. The increased rain did not allow substantial buildup of pollutants as evidenced in the chemical analysis of runoff from the Walnut Creek site for the second storm of 1977-78 (Figure 44 and Table 8).

Figures 40-43 show the results of bioassays for four unfiltered samples for the seasons second storm November 21, 1977, from the Walnut Creek monitoring site during the early 1977-78 winter. The general stimulatory nature of Walnut Creek runoff noted in the 1976-77 samples was consistant in the 1977-78 winter samples. The 1%, 5%, and 10% roadway runoff treatments for sample 1 showed an initial reduction in algal response while the .1% additions caused a slight stimulation during the first 24 hours of testing. During the remainder of the assay procedure, the lower treatments, i.e., .1% and 1%, were not significantly different from the controls. The larger additiona of 5% and 10% resulted in a substantial increase in productivity from hour 24 to 72 and an even more significant response in the latter test period.

Sample 8 (Figure 41) showed the same general response as sample 1 with the heavier additions being significantly stimulatory and the lower treatment levels less so. Interestingly, the chemical analyses for these two samples are essentially the same with no major differences in metal or nutrient content.

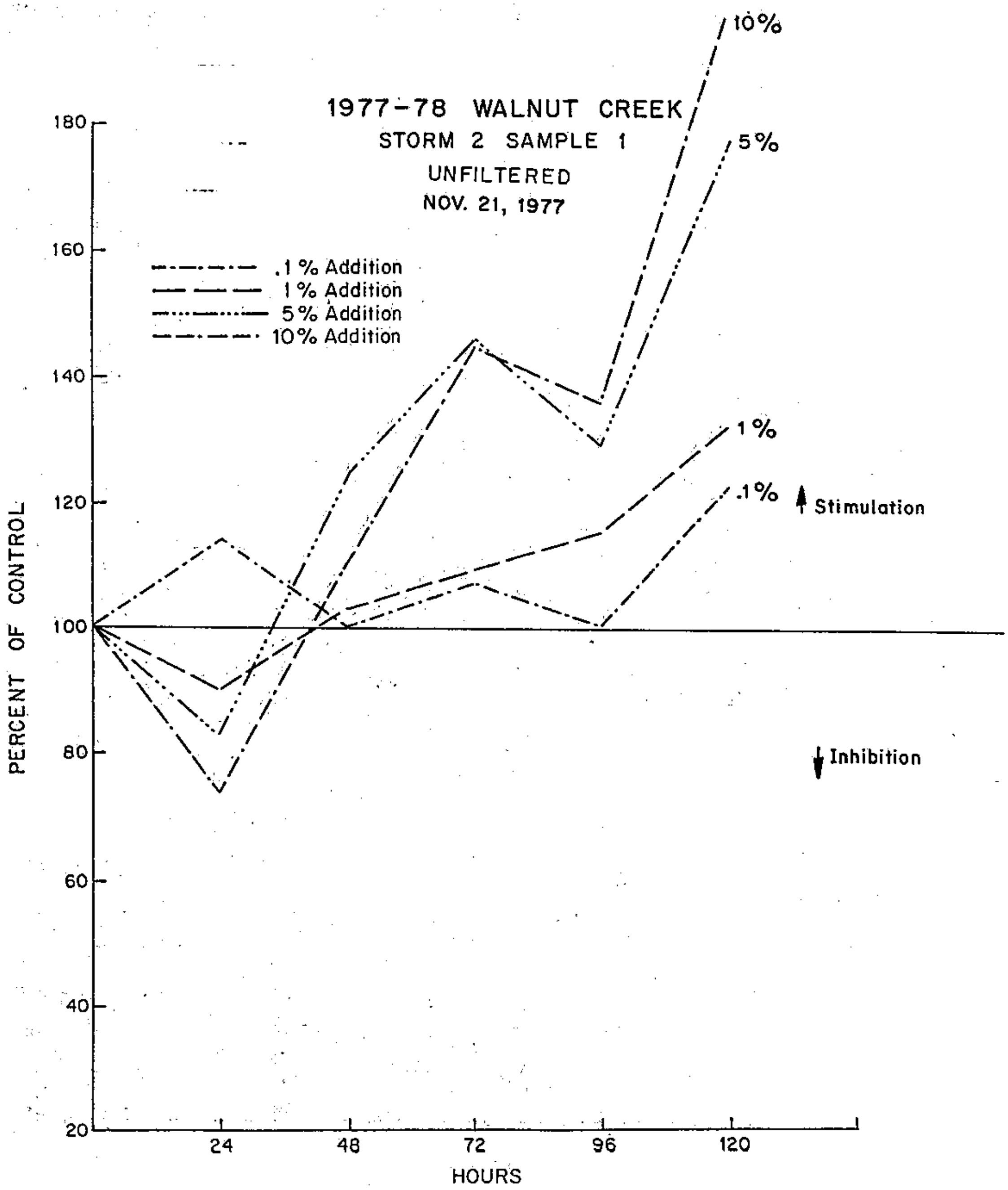

1977-78 WALNUT CREEK
STORM 2 SAMPLE 1
UNFILTERED
NOV. 21, 1977
.1 % Addition
1 % Addition
5 % Addition
10 % Addition
10%
5%
1%
.1%
Stimulation
Inhibition
PERCENT OF CONTROL
180
160
140
120
100
80
60
40
20
24
48
72
96
120
HOURS

FIGURE 40

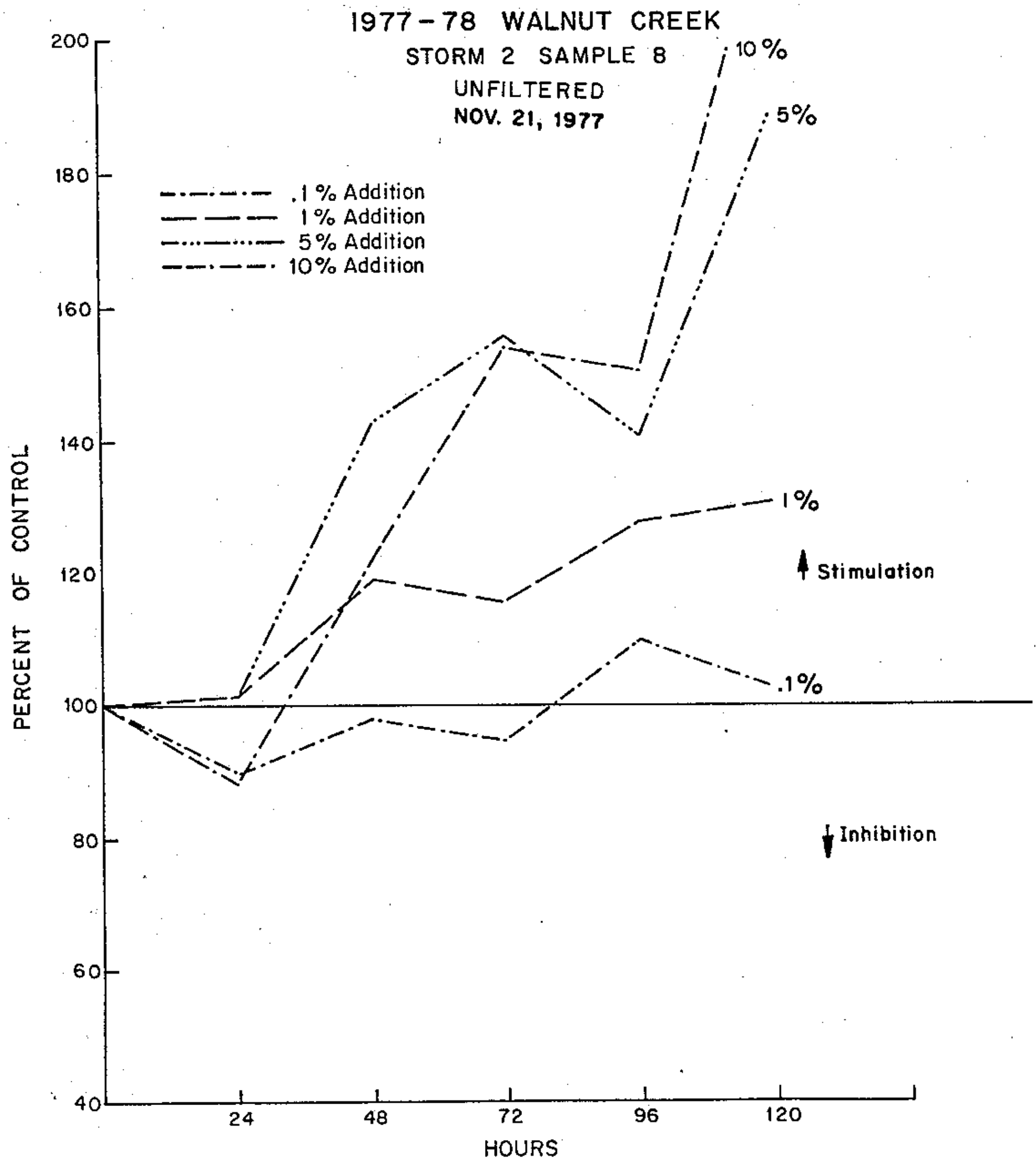

1977-78 WALNUT CREEK
STORM 2 SAMPLE 8
UNFILTERED
NOV. 21, 1977
.1% Addition
1% Addition
5% Addition
10% Addition
10%
5%
1%
.1%
Stimulation
Inhibition
PERCENT OF CONTROL
200
180
160
140
120
100
80
60
40
24
48
72
96
120
HOURS

FIGURE 41

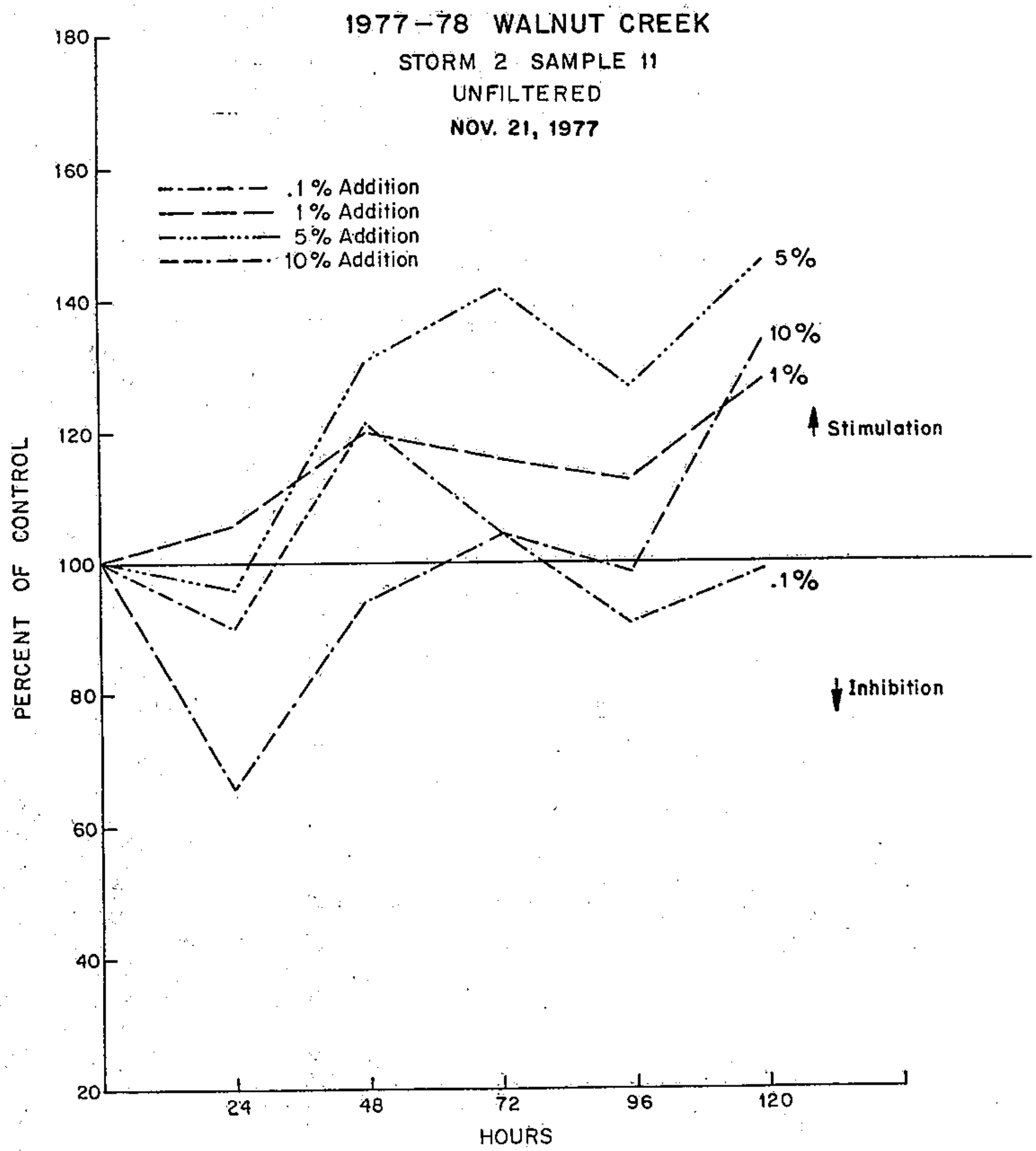

1977-78 WALNUT CREEK
STORM 2 SAMPLE 11
UNFILTERED
NOV. 21, 1977
.1 % Addition
1 % Addition
5 % Addition
10 % Addition
5%
10%
1%
.1%
Stimulation
Inhibition
PERCENT OF CONTROL
HOURS
180
160
140
120
100
80
60
40
20
24
48
72
96
120

FIGURE 42

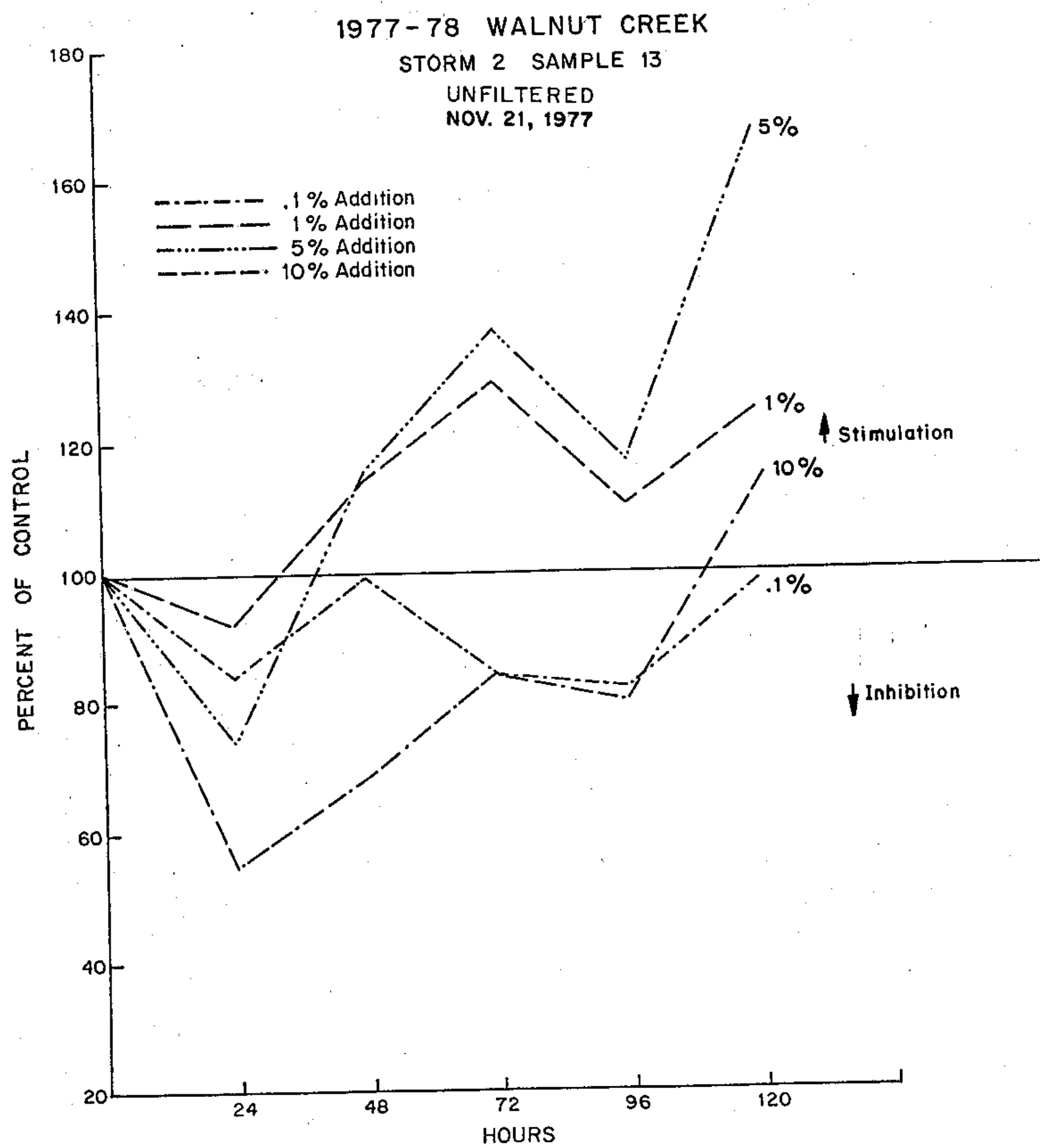

1977-78 WALNUT CREEK
STORM 2 SAMPLE 13
UNFILTERED
NOV. 21, 1977
.1 % Addition
1 % Addition
5 % Addition
10 % Addition
5%
1%
10%
.1%
Stimulation
Inhibition
PERCENT OF CONTROL
180
160
140
120
100
80
60
40
20
24
48
72
96
120
HOURS

FIGURE 43

Figure 44

RUNOFF CONCENTRATION FOR SELECTED CONSTITUENTS

Walnut Creek 1977–78

Storm No. 2 Nov. 21, 1977

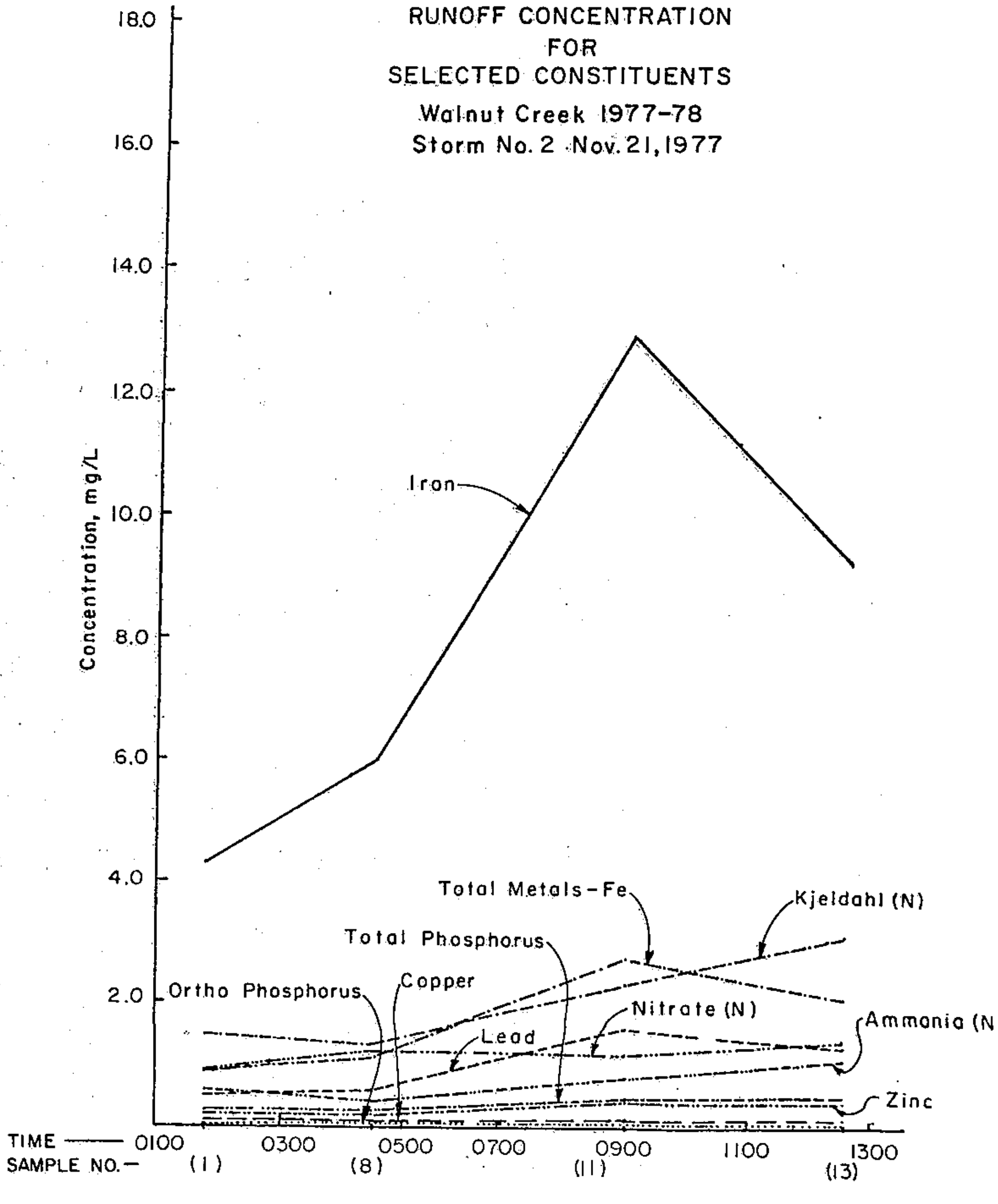


TABLE 8

Runoff Concentrations for Selected Chemical Constituents

Walnut Creek 1977-78
Storm No. 2 Nov. 21, 1977

	Concentration Mg/l			
Sample Number	1	8	11	13
<u>METALS</u>				
Iron (Fe)	4.3	6.0	13.0	9.3
Total Metals - Fe	0.93	1.06	2.67	2.06
Lead (Pb)	0.50	0.60	1.6	1.3
Zinc (Zn)	0.18	0.20	0.40	0.38
Copper (Cu)	0.07	0.08	0.12	0.11
<u>NUTRIENTS</u>				
Nitrate Nitrogen	0.9	1.0	1.2	1.6
Kjeldahl Nitrogen	1.5	1.3	2.3	3.1
Ammonia Nitrogen	0.6	0.4	0.8	1.1
Total Phosphorus	0.21	0.20	0.38	0.38
Ortho Phosphate	0.09	0.09	0.11	0.08
TOTAL	3.30	2.99	4.79	6.26

In contrast, samples 11 and 13 have somewhat higher metal levels. This may have had some effect on the algal response shown in Figures 42 and 43. In both bioassays the general trend was one of stimulation, through there was a substantial inhibitory period during the early stages of the bioassays. In contrast to samples 1 and 8, the 10% treatment of samples 11 and 13 did not cause substantial stimulation, but there was a general upswing during the latter bioassay period. Metals at the higher levels may have affected the algal response. The 5% additions in samples 11 and 13 showed substantial stimulatory effects during the bioassay; suggesting the sample 11 and 13 pollutant level at 5% approximated the 10% level in samples 1 and 8.

Los Angeles

The Los Angeles runoff samples produced the most pronounced inhibitory affects on algal response during the bioassay tests conducted during this project. Only in one or two cases was there significant stimulation of algal growth during testing. Even in these bioassays stimulation occurred in a haphazard manner with no general stimulatory trend apparent. Treatments above the 1% level resulted in significant, and in one case, very significant inhibition of algal response.

The Los Angeles monitoring site had a high average daily traffic (185,000 vehicles) resulting in a higher accumulation of deleterious runoff constituents. The first storm samples in Los Angeles during the 1976-77 winter (December 30, 1976) were taken approximately 48 days after the previous rain event. This resulted in substantial runoff contamination, particularly in the first samples. The samples were chosen with the idea of bioassaying the start of this storm (sample 1). the middle portion (samples 5 - 7) and the latter portion of the storm (sample 10). The chemical analysis of selected metals and nutrients (Figure 51 and Table 9) shows a general reduction of runoff pollutant constituents as the storm progressed. Even with the lowered metal content of the latter samples, the bioassays indicated that the higher treatment (10%) seriously inhibited algal response. This indicated that tolerance levels for the algal populations were exceeded at increased levels of pavement runoff constituents.

Sample 1 was bioassayed as a filtered and unfiltered sample to compare the responses (Figures 45 and 46). The unfiltered sample (Figure 60) caused a substantial inhibition at the 10% treatment level as well as a significant inhibition at 1% additions. The treatment levels <1% had resulted in no significant effects on the algal cultures. The filtered sample (Figure 61) caused almost as much inhibition at the 10% level as the unfiltered sample. The 1% treatment resulted in less inhibition and, with the exception of the 24 and 48 hour values, was not significantly different from the controls. The 10% filtered additon remained very inhibitory. Filtering was not successful in eliminating the inhibitory agent from the runoff.

The sample 5 bioassay (Figure 47) exhibited basically the same pattern as sample 1. There was some stimulation of algal growth during the bioassay with lower treatment levels. The 10% treatments showed very significant inhibition effects. While there was some stimulation at the lower additions of pavement runoff during this bioassay, by day four they were indistinguishable from the controls.

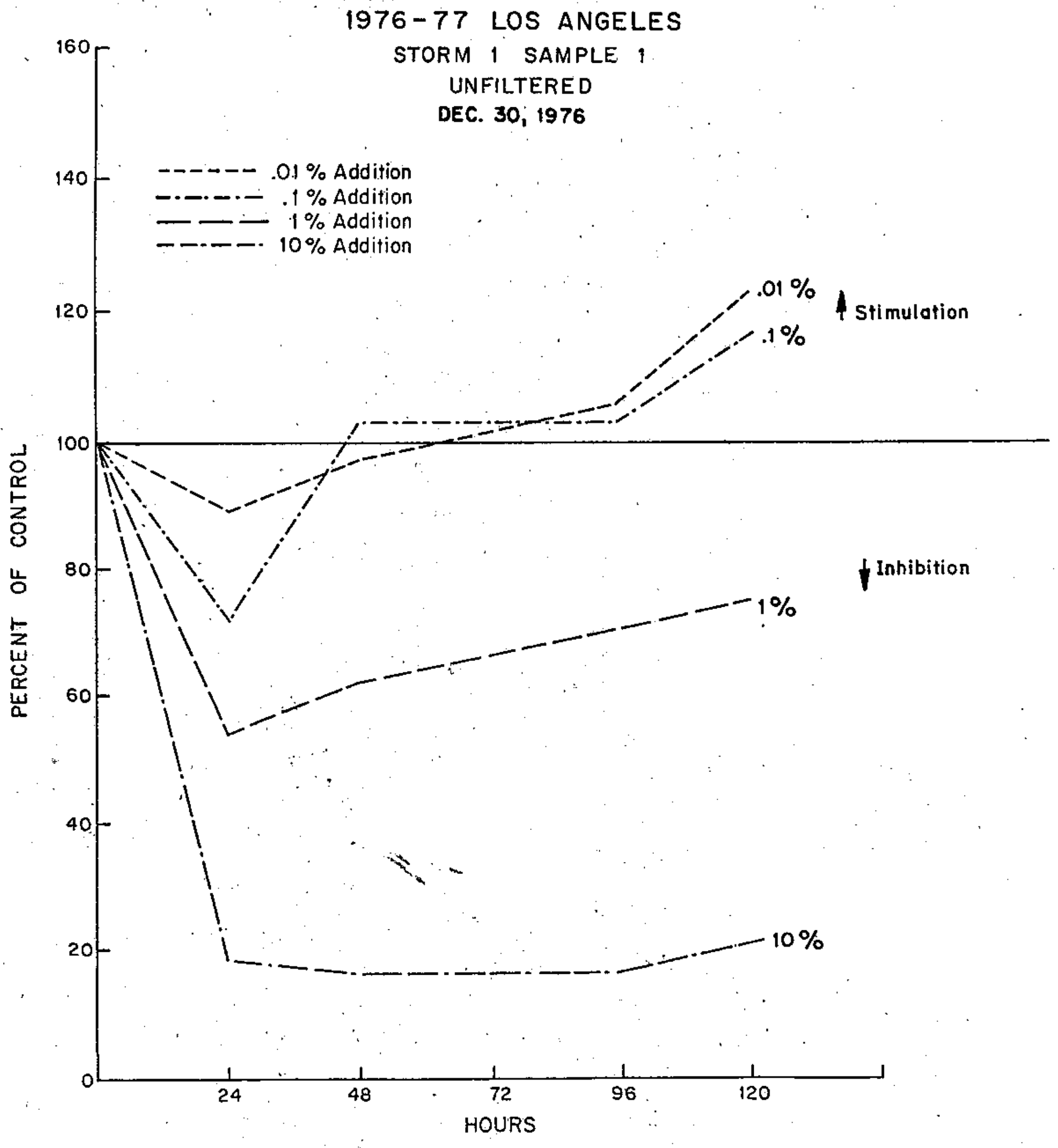
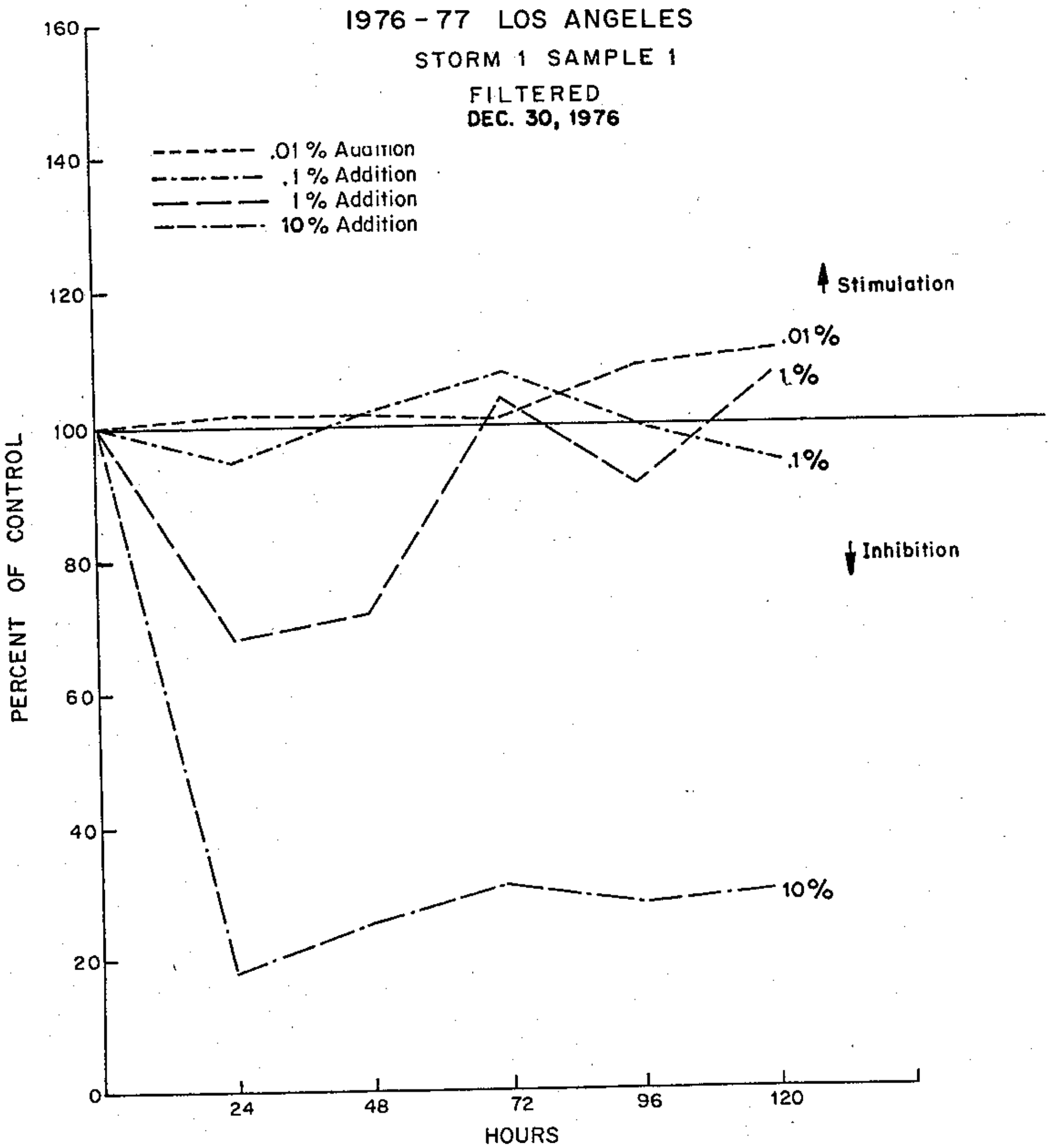
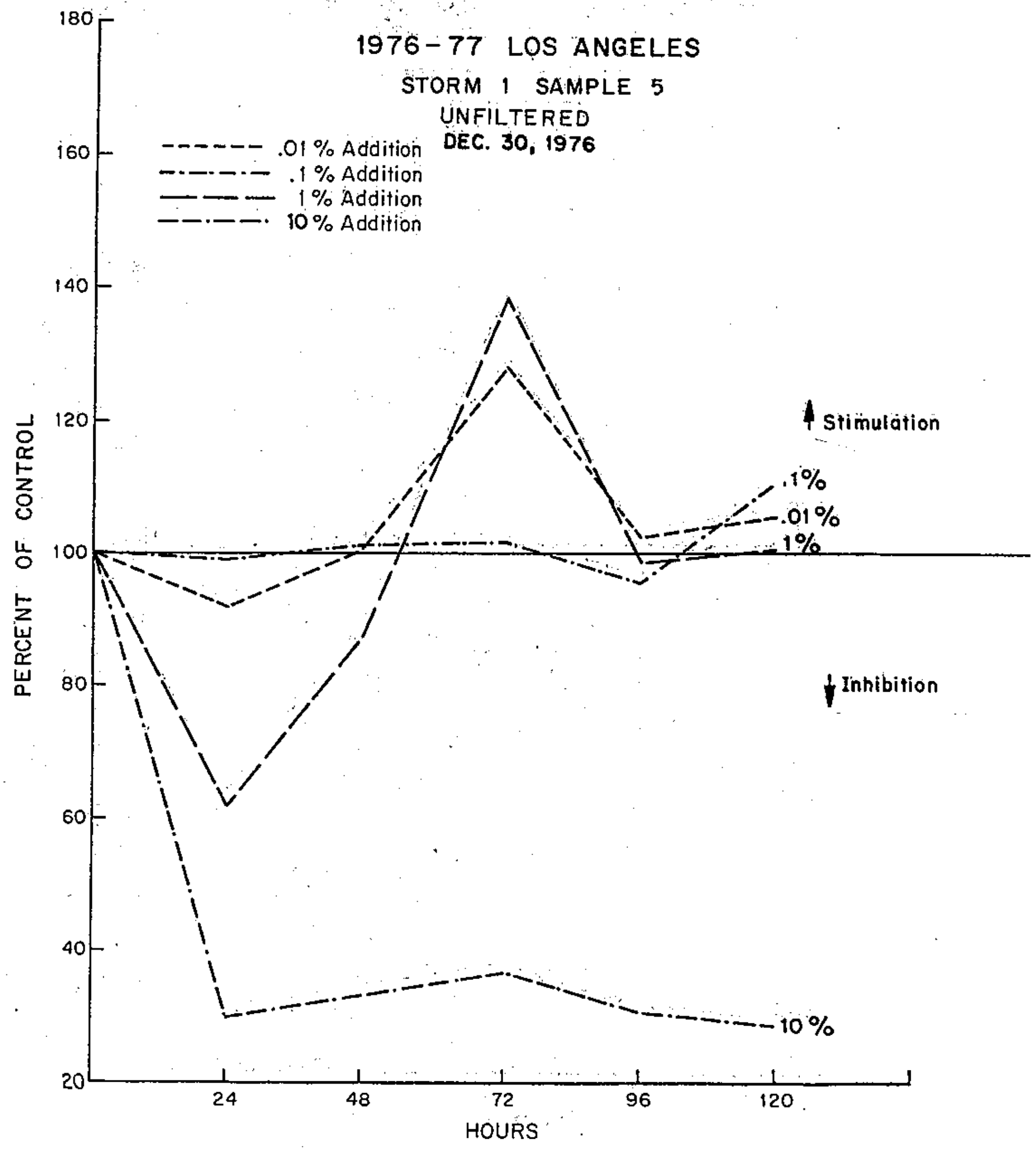

1976-77 LOS ANGELES
STORM 1 SAMPLE 1
UNFILTERED
DEC. 30, 1976
.01 % Addition
.1 % Addition
1 % Addition
10 % Addition
.01 %
.1 %
Stimulation
Inhibition
1 %
10 %
PERCENT OF CONTROL
160
140
120
100
80
60
40
20
0
24
48
72
96
120
HOURS

FIGURE 45



1976 - 77 LOS ANGELES
STORM 1 SAMPLE 1
FILTERED
DEC. 30, 1976
.01 % Auaition
.1 % Addition
1 % Addition
10 % Addition
Stimulation
Inhibition
.01%
1%
.1%
10%
PERCENT OF CONTROL
HOURS
0
20
40
60
80
100
120
140
160
24
48
72
96
120

FIGURE 46



1976-77 LOS ANGELES
STORM 1 SAMPLE 5
UNFILTERED
DEC. 30, 1976
.01 % Addition
.1 % Addition
1 % Addition
10 % Addition
180
160
140
120
100
80
60
40
20
PERCENT OF CONTROL
Stimulation
Inhibition
.1%
.01%
1%
10%
24
48
72
96
120
HOURS

FIGURE 47

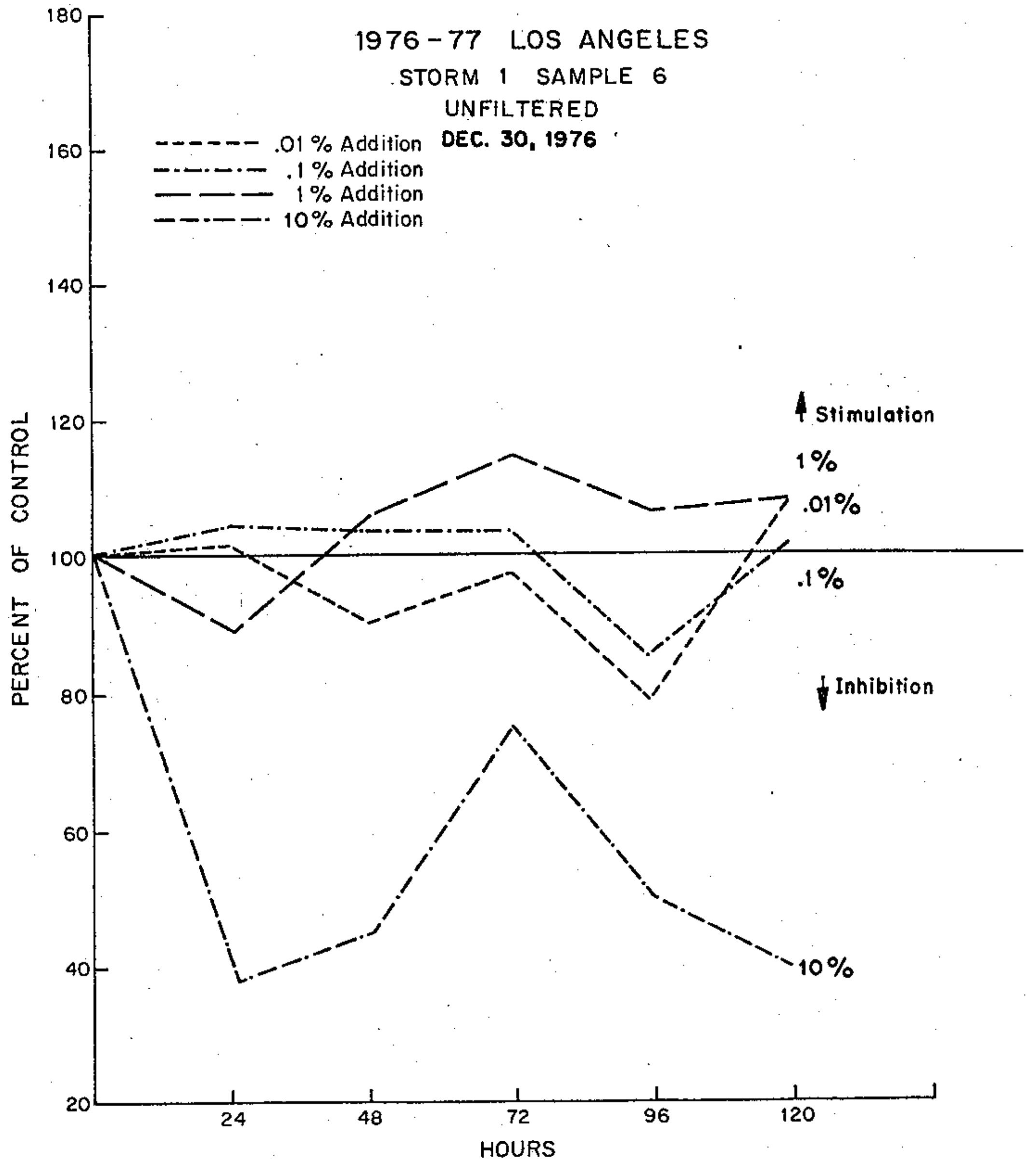

1976-77 LOS ANGELES
STORM 1 SAMPLE 6
UNFILTERED
DEC. 30, 1976
.01 % Addition
.1 % Addition
1 % Addition
10% Addition
Stimulation
Inhibition
1%
.01%
.1%
10%
PERCENT OF CONTROL
180
160
140
120
100
80
60
40
20
24
48
72
96
120
HOURS

FIGURE 48

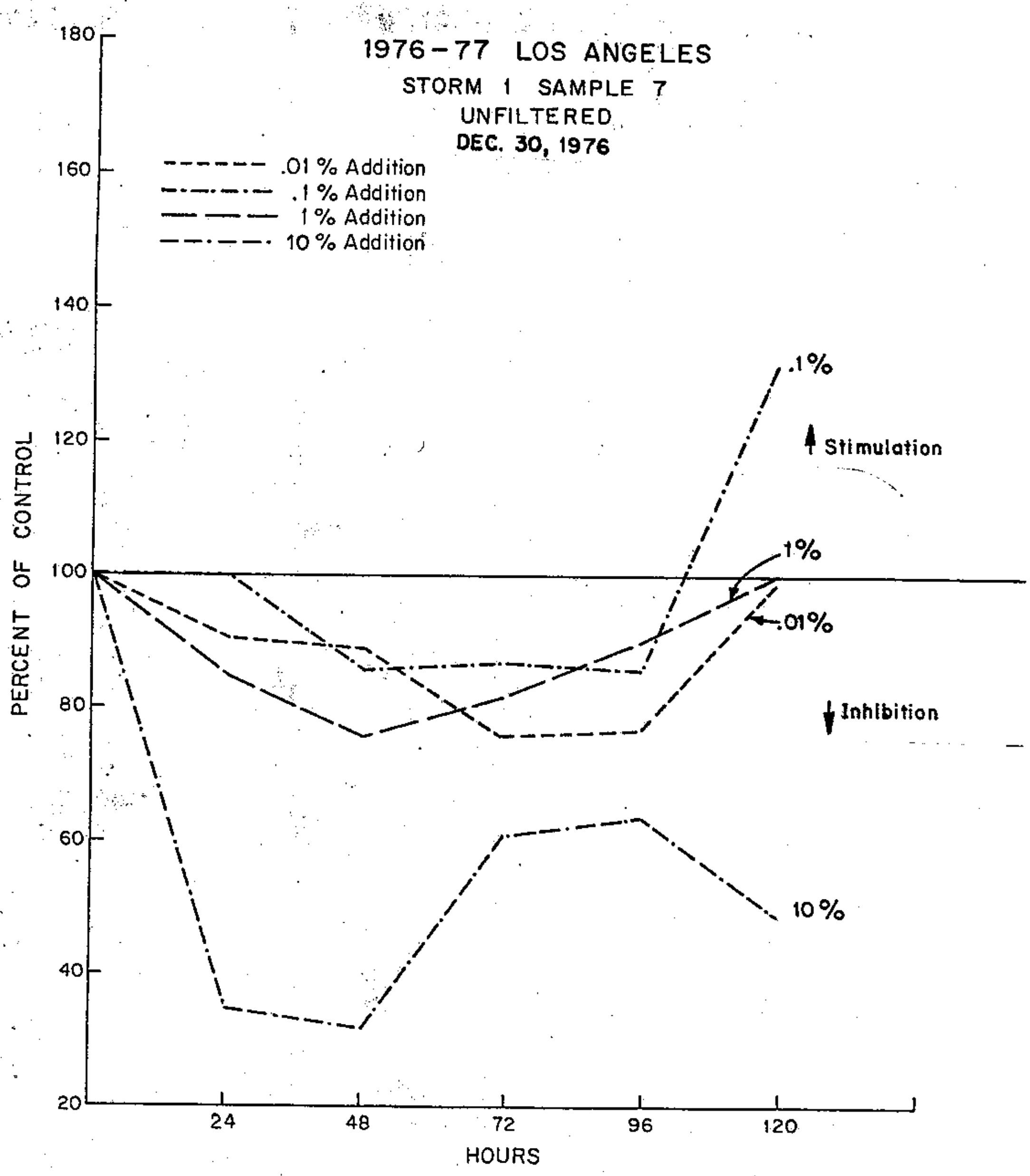

1976-77 LOS ANGELES
STORM 1 SAMPLE 7
UNFILTERED
DEC. 30, 1976
.01 % Addition
.1 % Addition
1 % Addition
10 % Addition
PERCENT OF CONTROL
180
160
140
120
100
80
60
40
20
24
48
72
96
120
HOURS
.1%
Stimulation
1%
.01%
Inhibition
10 %

FIGURE 49

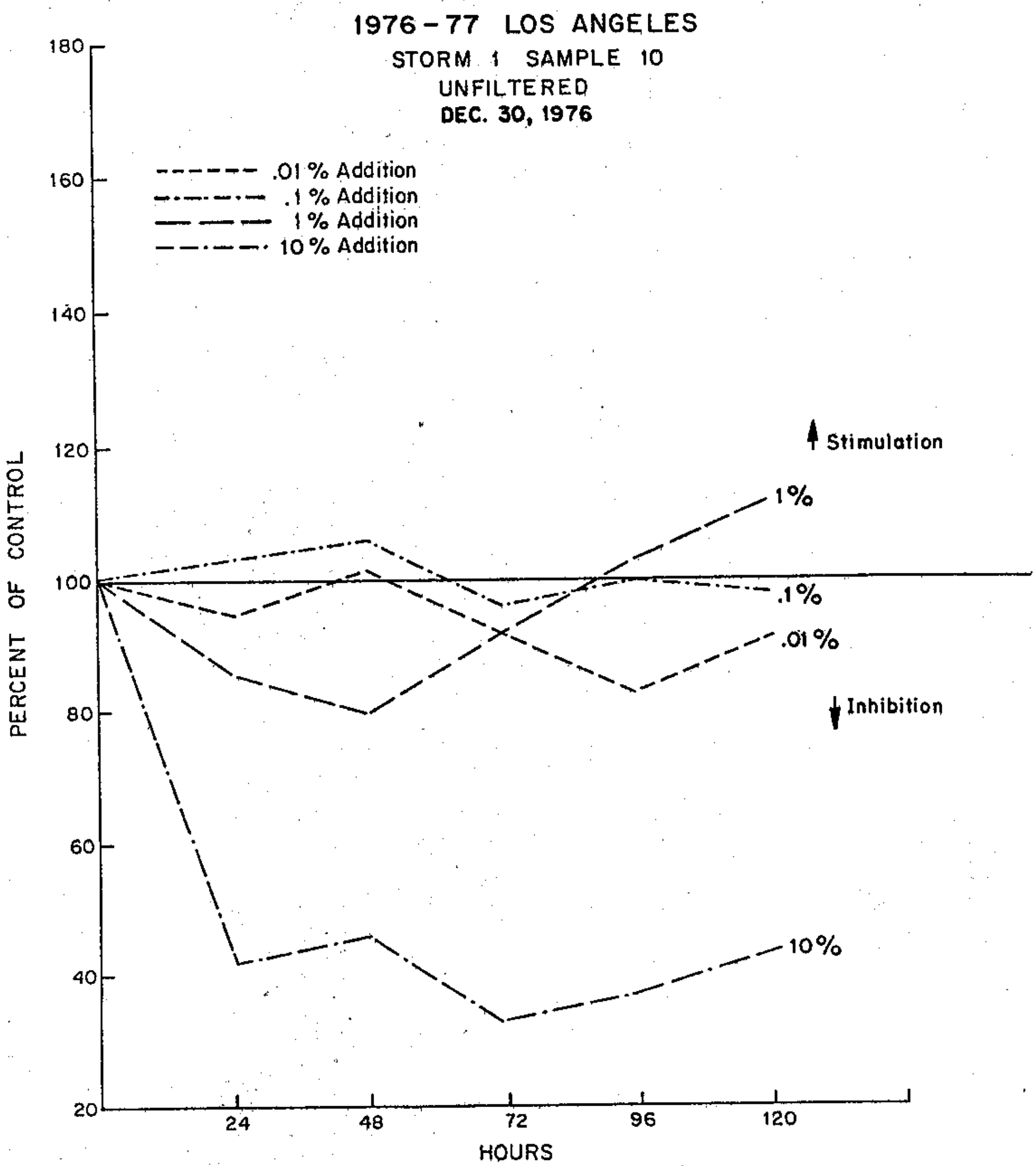

1976-77 LOS ANGELES
STORM 1 SAMPLE 10
UNFILTERED
DEC. 30, 1976
.01 % Addition
.1 % Addition
1 % Addition
10 % Addition
Stimulation
Inhibition
1%
.1%
.01%
10%
PERCENT OF CONTROL
180
160
140
120
100
80
60
40
20
24
48
72
96
120
HOURS

FIGURE 50

Figure 51

RUNOFF CONCENTRATION FOR SELECTED CONSTITUENTS

Los Angeles 1976-77

Storm No.1 Dec. 30, 1976

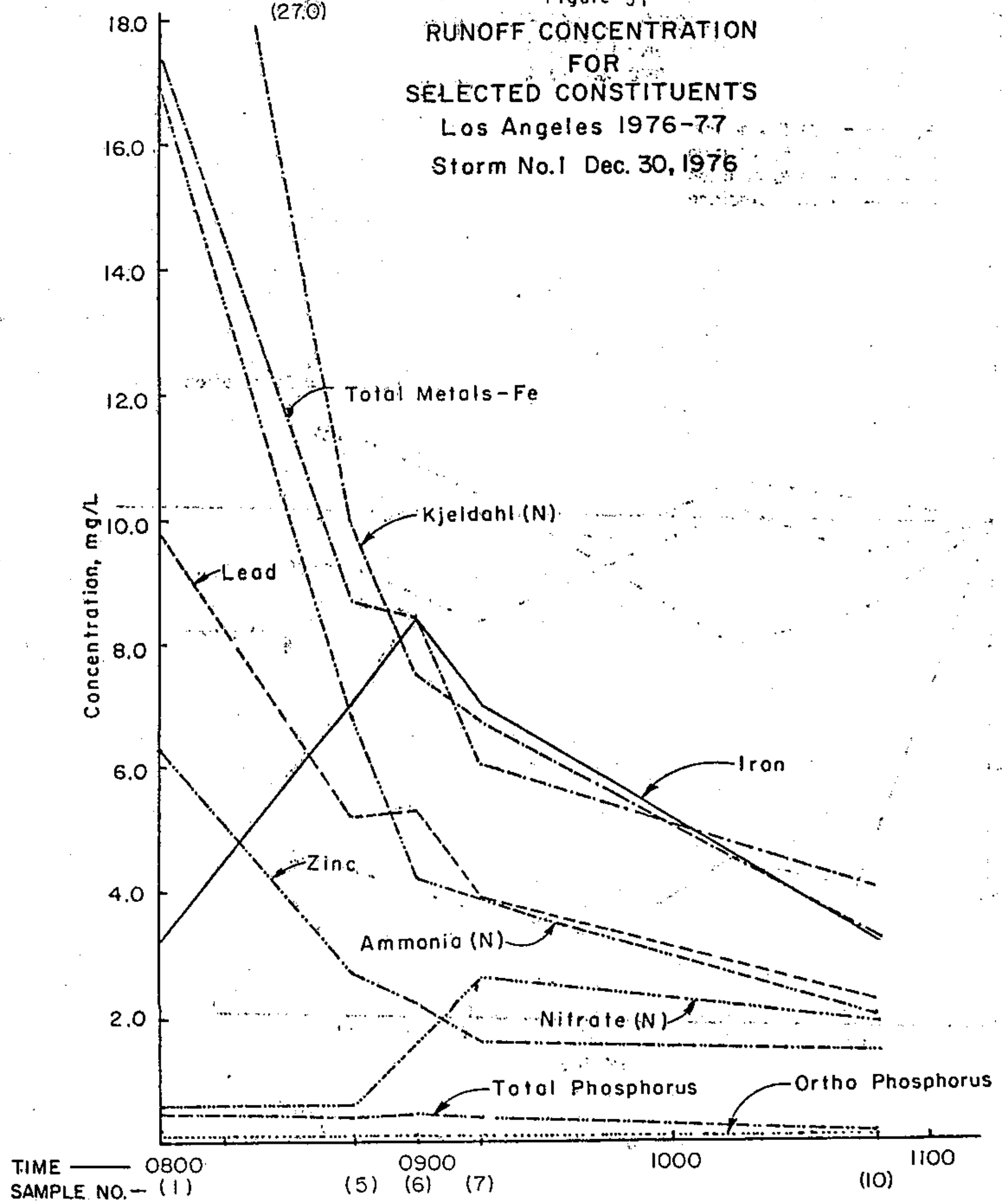


TABLE 9

Runoff Concentrations for Selected Chemical Constituents

Los Angeles 1976-77
Storm No. 1 Dec. 30, 1976

	Concentration Mg/l				
Sample Number	1	5	6	7	10
METALS					
Iron (Fe)	3.2	1.0	8.4	1.2	2.6
Total Metals - Fe	17.49	8.72	8.45	5.91	3.71
Lead (Pb)	9.8	5.2	5.6	3.9	2.0
zinc	6.3	2.6	2.2	1.5	1.4
Copper (Cu)	0.21	0.12	0.13	0.12	0.06
NUTRIENTS					
Nitrate Nitrogen	0.55	0.65	1.7	2.6	1.7
Kjeldahl Nitrogen	27.0	10.0	7.5	6.7	3.1
Ammonia Nitrogen	17.0	7.0	4.2	3.1	2.0
Total Phosphorus	0.59	0.42	0.50	0.39	0.16
Ortho Phosphate	0.15	0.09	0.11	0.08	0.03
TOTAL	45.29	18.16	14.01	12.87	6.99

The 10% treatment level of samples 6 and 7 (Figures 48 and 49) was not as inhibitory as the earlier samples from this storm and also fluctuated to a certain degree although the general trend of inhibition was evident. The effect of lower level treatments were not significant from controls. Sample 10 (Figure 50) results were essentially the same as samples 6 and 7.

Figures 52-54 are the results of bioassays run on runoff the second Los Angeles storm (March 1, 1976) of the 1976-77 Winter. Samples were collected two days after a prior substantial storm. Figure 55 and Table 10 show the relatively low levels of contaminants found in these samples compared to the other Los Angeles samples, which were from storms with more lengthy periods of prior dry weather.

Results from sample 1 (Figure 52) showed a substantial inhibition of algal productivity at the higher roadway runoff treatment levels. This was similar to the algal response to runoff from the first Los Angeles storm sampled during the 1976-77 winter. The 10% addition resulted in substantial inhibition and algal productivity remained depressed during the entire test period. While the 10% addition were definitely significant, the 5% addition approached the significant inhibition level. One percent treatments were indistinguishable from the control while the lower additions (.01%. 1%) were slightly stimulatory.

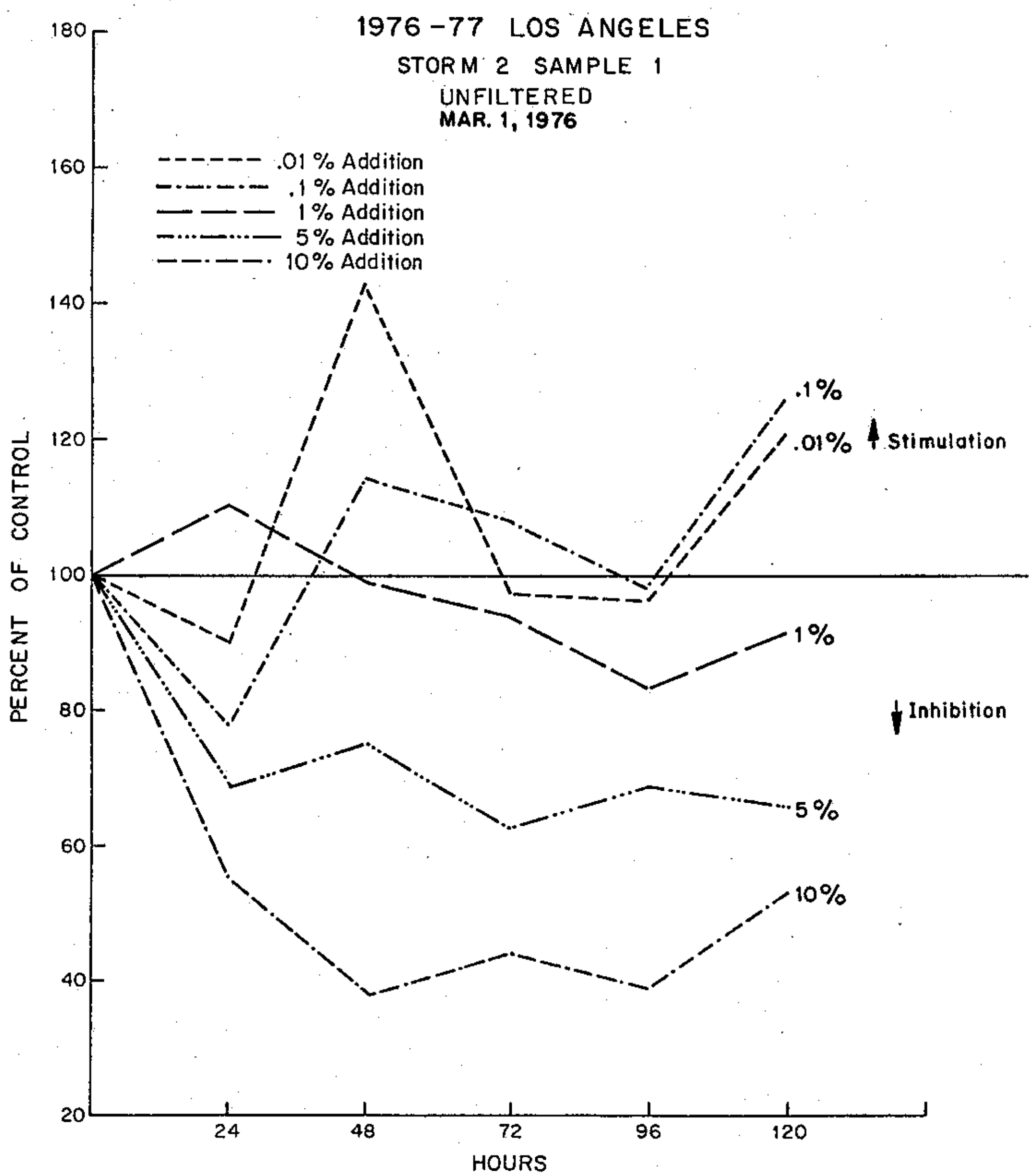
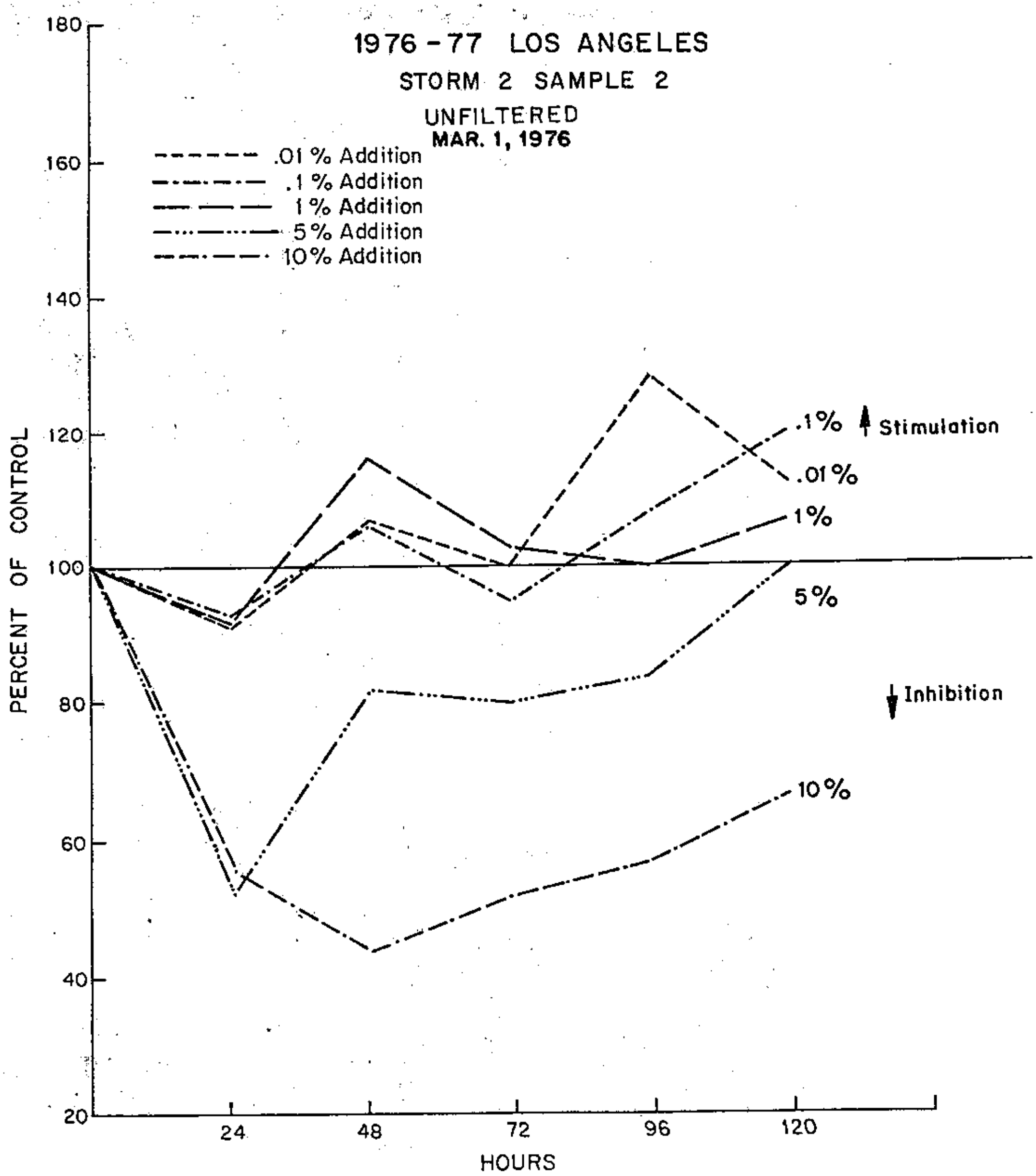

1976 - 77 LOS ANGELES
STORM 2 SAMPLE 1
UNFILTERED
MAR. 1, 1976
.01 % Addition
.1 % Addition
1 % Addition
5 % Addition
10 % Addition
PERCENT OF CONTROL
180
160
140
120
100
80
60
40
20
.1%
.01%
Stimulation
1%
Inhibition
5%
10%
24
48
72
96
120
HOURS

FIGURE 52



1976 - 77 LOS ANGELES
STORM 2 SAMPLE 2
UNFILTERED
MAR. 1, 1976
.01 % Addition
.1 % Addition
1 % Addition
5 % Addition
10 % Addition
PERCENT OF CONTROL
180
160
140
120
100
80
60
40
20
24
48
72
96
120
HOURS
.1%
Stimulation
.01%
1%
5%
Inhibition
10%

FIGURE 53

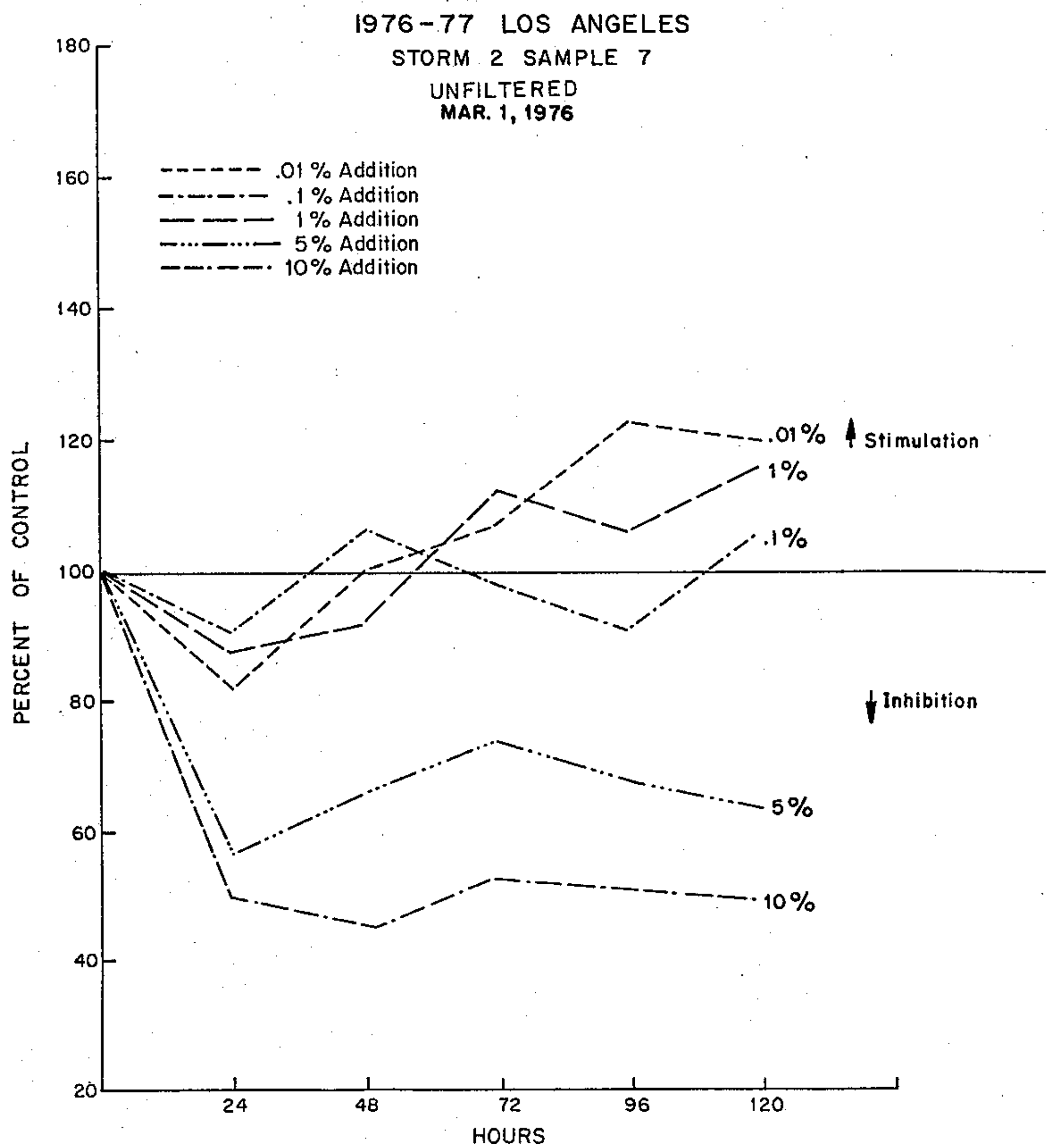

1976-77 LOS ANGELES
STORM 2 SAMPLE 7
UNFILTERED
MAR. 1, 1976
.01 % Addition
.1 % Addition
1 % Addition
5 % Addition
10 % Addition
PERCENT OF CONTROL
180
160
140
120
100
80
60
40
20
24
48
72
96
120
HOURS
.01 %
1 %
.1 %
5 %
10 %
Stimulation
Inhibition

FIGURE 54

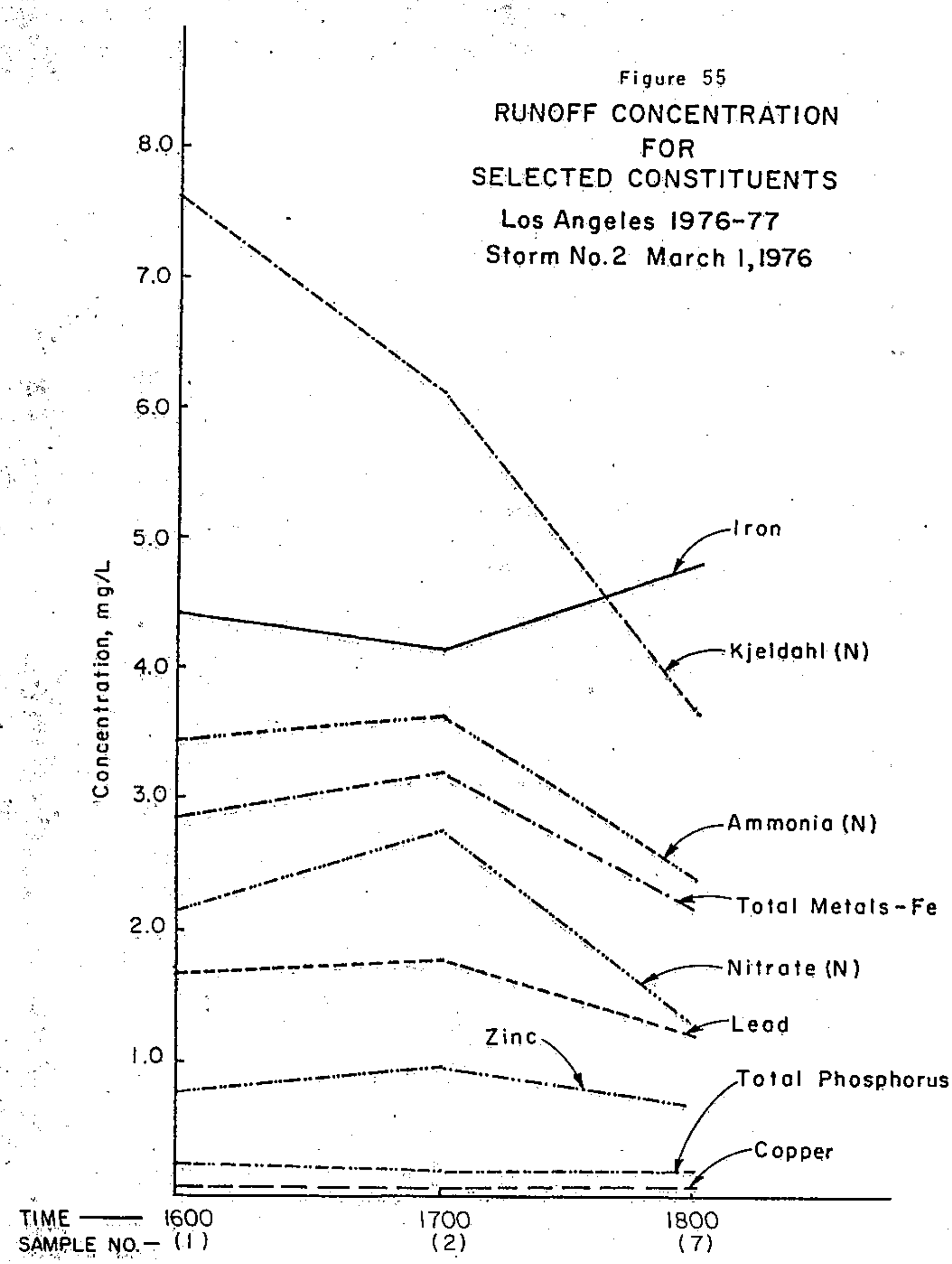


Figure 55
RUNOFF CONCENTRATION
FOR
SELECTED CONSTITUENTS
Los Angeles 1976-77
Storm No. 2 March 1, 1976
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
Concentration, mg/L
Iron
Kjeldahl (N)
Ammonia (N)
Total Metals - Fe
Nitrate (N)
Lead
Zinc
Total Phosphorus
Copper
TIME — 1600
SAMPLE NO. — (1)
1700
(2)
1800
(7)

TABLE 10

Runoff Concentrations for Selected Chemical Constituents

Los Angeles 1976-77
Storm No. 2 March 1, 1976

	Concentration Mg/l		
Sample Number	1	2	7
METALS			
Iron (Fe)	4.5	4.2	7.0
Total Metals - Fe	2.92	3.25	2.25
Lead (Pb)	3.3	4.7	2.1
Zinc (Zn)	3.1	3.0	1.5
Copper (Cu)	0.13	0.14	0.06
NUTRIENTS			
Nitrate Nitrogen	2.2	2.8	1.3
Kjeldahl Nitrogen	7.7	6.2	3.7
Ammonia Nitrogen	3.5	3.7	2.4
Total Phosphorus	0.27	0.23	0.23
Ortho Phosphate	0.09	0.10	0.10
TOTAL	13.76	13.03	7.73

Sample 2 (Figure 53) tended to group the lower runoff concentrations responses within the normal fluctuations of the control; however, inhibition at the higher additions was evident. The 10% treatment was significantly deleterious to the algal cultures and remained so during the course of the bioassay. Initial response to the 5% treatments was inhibition, but the algae recovered and by the end of the bioassay run the culture returned to parity with the control group.

Sample 7 (Figure 54) showed inhibition by higher additions as expected. The 5% level remained inhibitory rather than returning to normal as in sample 2. The lower level treatments had little effect on the cultures except a slight stimulation during the latter period of the assays.

Chemical results (Figure 55) indicate the washing of the roadway surface by recent rains removed much of the metals and pollutants normally associated with Los Angeles runoff. The higher percentage roadway runoff treatments contained sufficient contaminants to inhibit growth, but the lower treatments displayed little effect and, in some cases, caused mild stimulation of the algae.

The runoff samples collected during the third Los Angeles storm (March 16, 1976) of the 1976-77 winter provided the most dramatic algal inhibition evidenced during the study.

The runoff sample was from an event 13 days after the last storm. The 13 dry days allowed additional pollutants to accumulate. Three samples from this storm were assayed using filtered and unfiltered runoff.

Figures 56-61 show the bioassay results of samples 1, 2 and 6 for the March 16, 1976 storm. Figure 62 and Table 11 give the chemical results for these samples. Full chemical analysis data are available in Appendix B.

The data again indicate that a dry period between storm events allows a substantial buildup of pollutants and inhibition of algal growth. Both the first and third Los Angeles storms had extended dry period prior to sampling. Comparing chemical data between these storms and the second storms, which lacked a significant preceding dry perid, show substantial differences.

It is apparent that runoff constituent concentrations decreased during the progression of the storm. There was a decrease in chemical concentration during sampling period 6; however, the sample bioassay results still show substantial effects on the algal cultures.

Figure 56 shows unfiltered assay results for sample one. Figure 57 give filtered results. Both the 5% and 10% treatments resulted in serious inhibition of algal productivity. Algal growth was virtually stopped by the 10% addition and the 5% addition was only slightly less detrimental.

Additionally, the 1% addition, which was normally slightly inhibitory, caused a significant reduction of algal growth

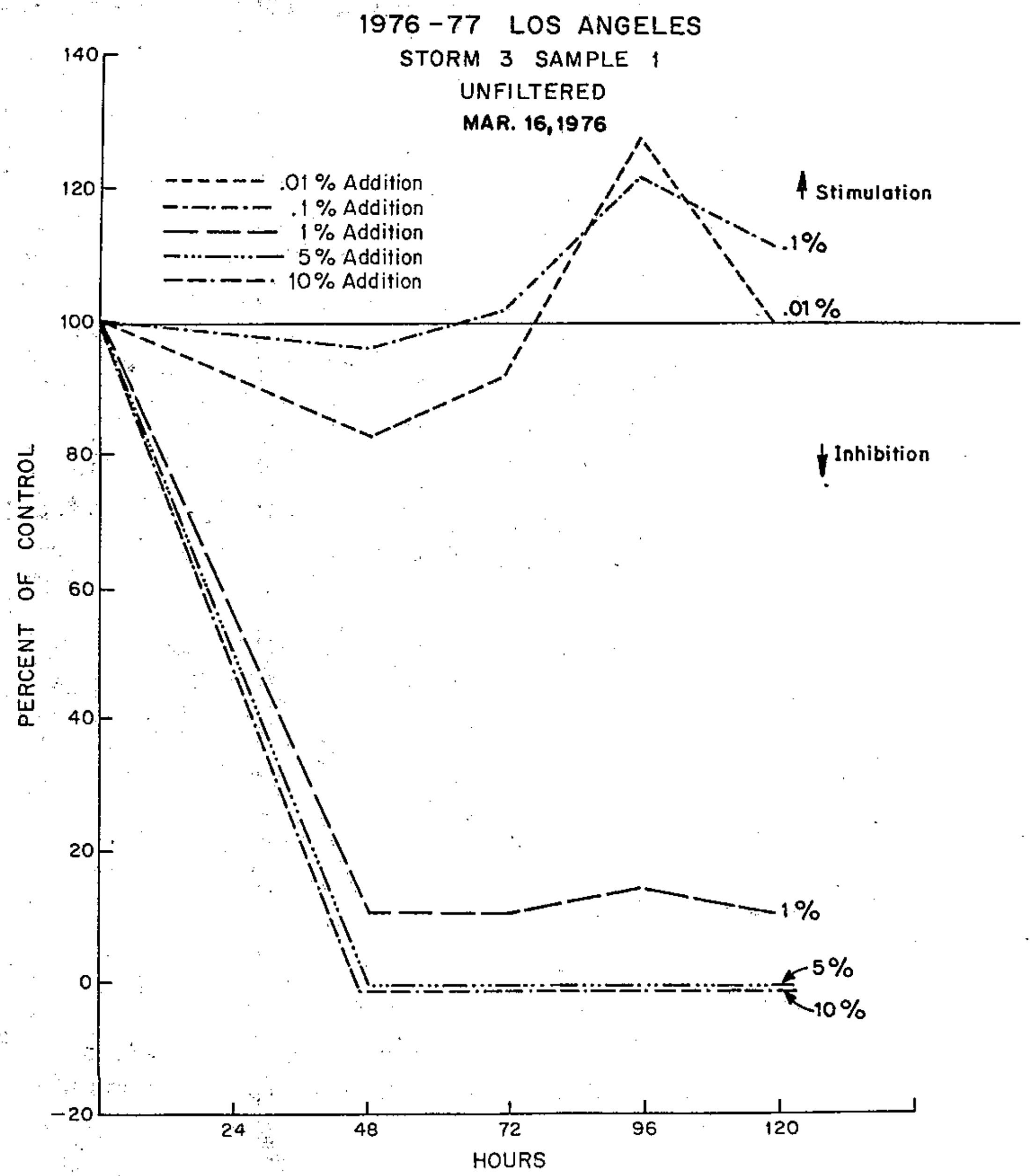
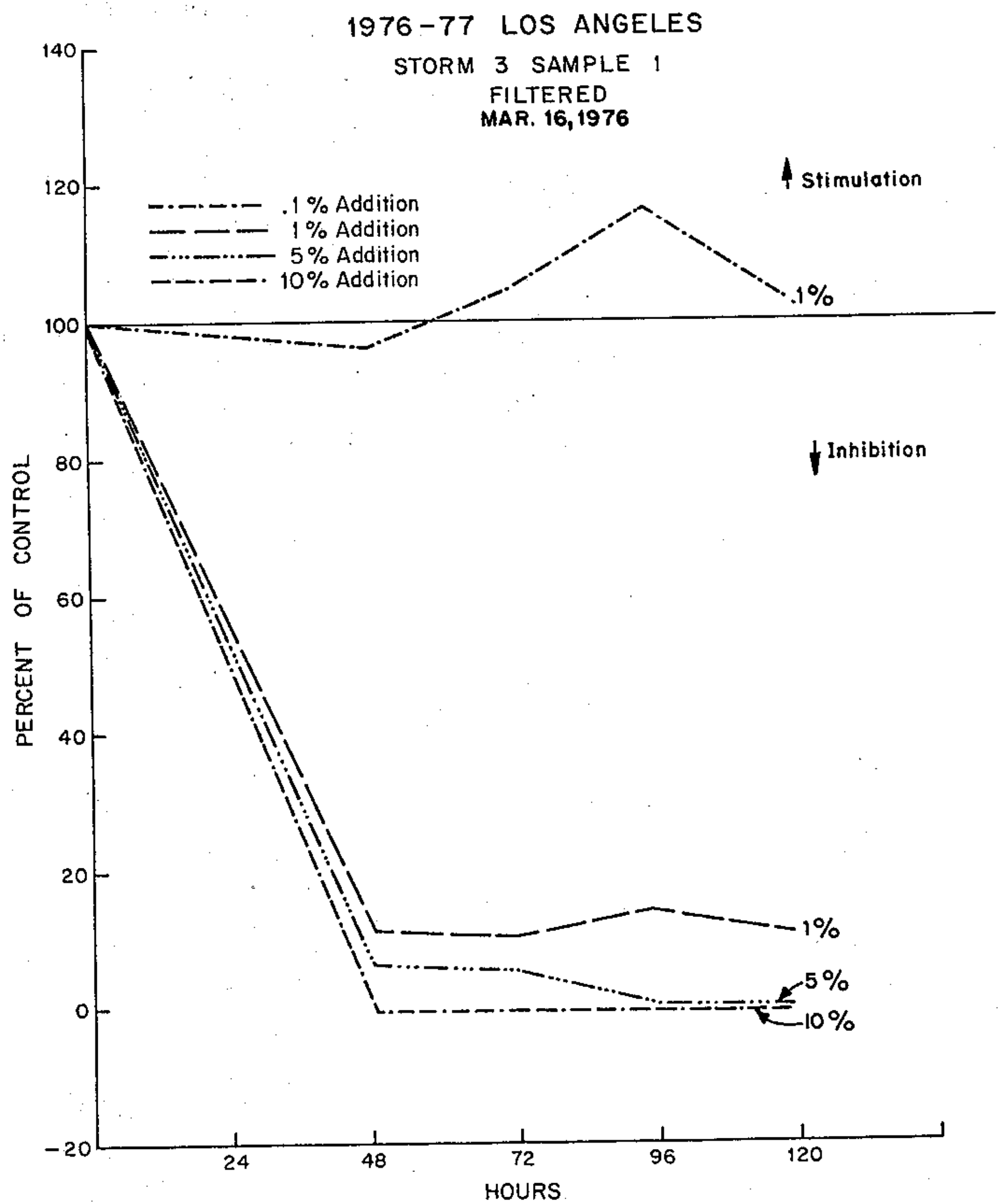

1976 - 77 LOS ANGELES
STORM 3 SAMPLE 1
UNFILTERED
MAR. 16, 1976
.01 % Addition
.1 % Addition
1 % Addition
5 % Addition
10 % Addition
Stimulation
Inhibition
.1%
.01 %
1 %
5 %
10 %
PERCENT OF CONTROL
HOURS
140
120
100
80
60
40
20
0
-20
24
48
72
96
120

FIGURE 56



1976-77 LOS ANGELES
STORM 3 SAMPLE 1
FILTERED
MAR. 16, 1976
.1 % Addition
1 % Addition
5 % Addition
10% Addition
Stimulation
Inhibition
.1%
1%
5%
10%
PERCENT OF CONTROL
140
120
100
80
60
40
20
0
-20
24
48
72
96
120
HOURS

FIGURE 57

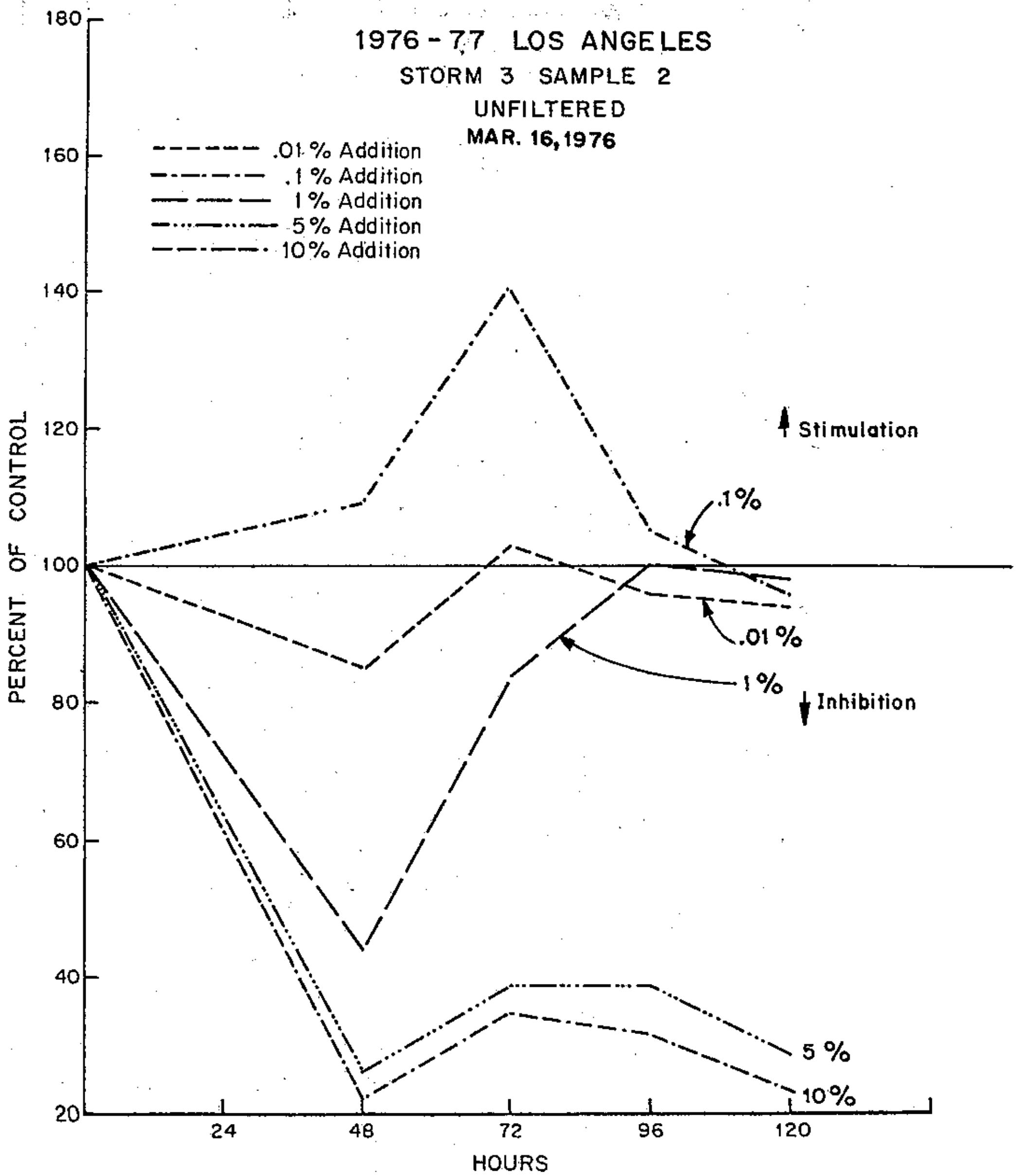

1976 - 77 LOS ANGELES
STORM 3 SAMPLE 2
UNFILTERED
MAR. 16, 1976
.01 % Addition
.1 % Addition
1 % Addition
5 % Addition
10 % Addition
Stimulation
Inhibition
.1%
.01 %
1 %
5 %
10%
PERCENT OF CONTROL
180
160
140
120
100
80
60
40
20
24
48
72
96
120
HOURS

FIGURE 58

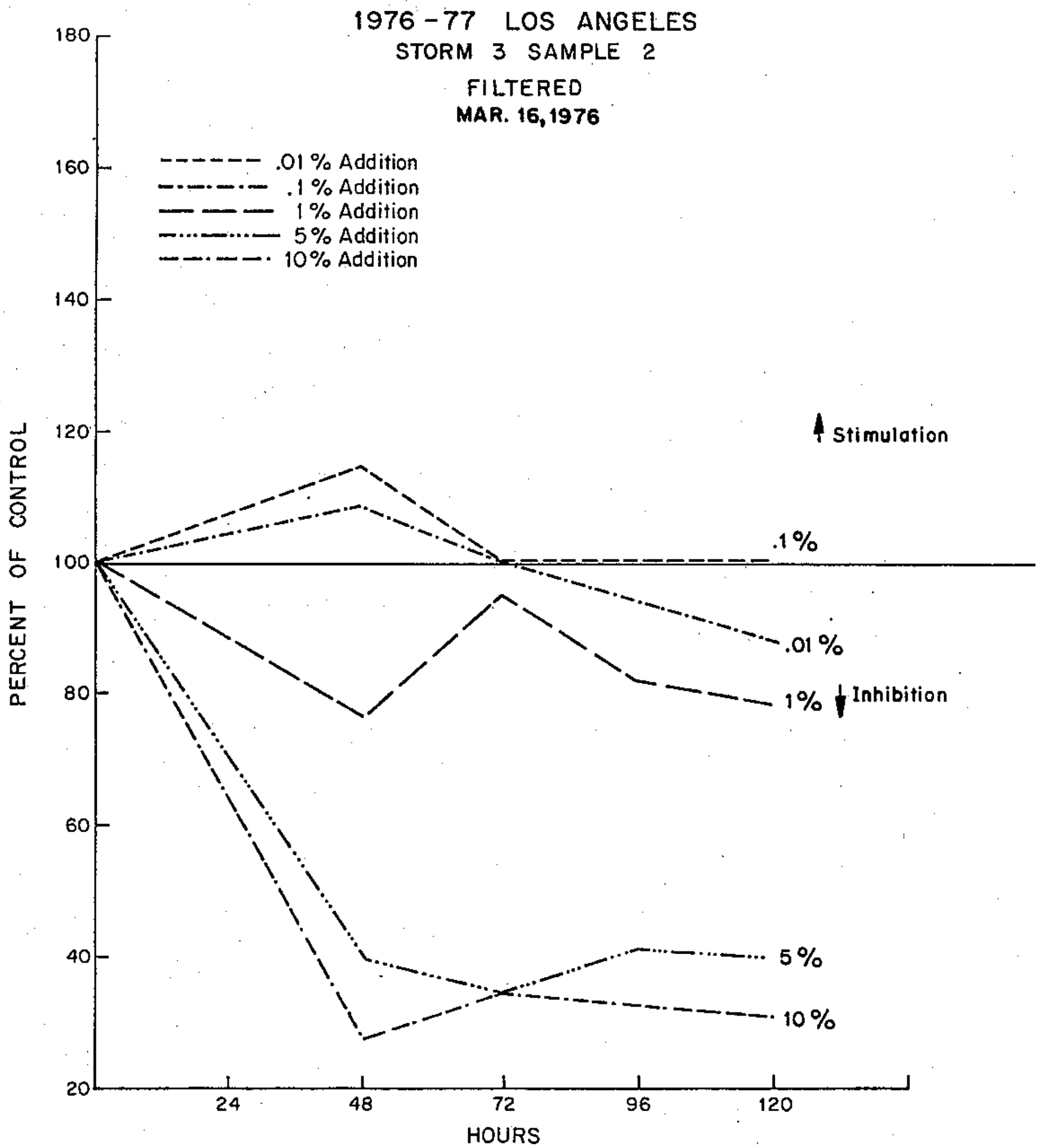
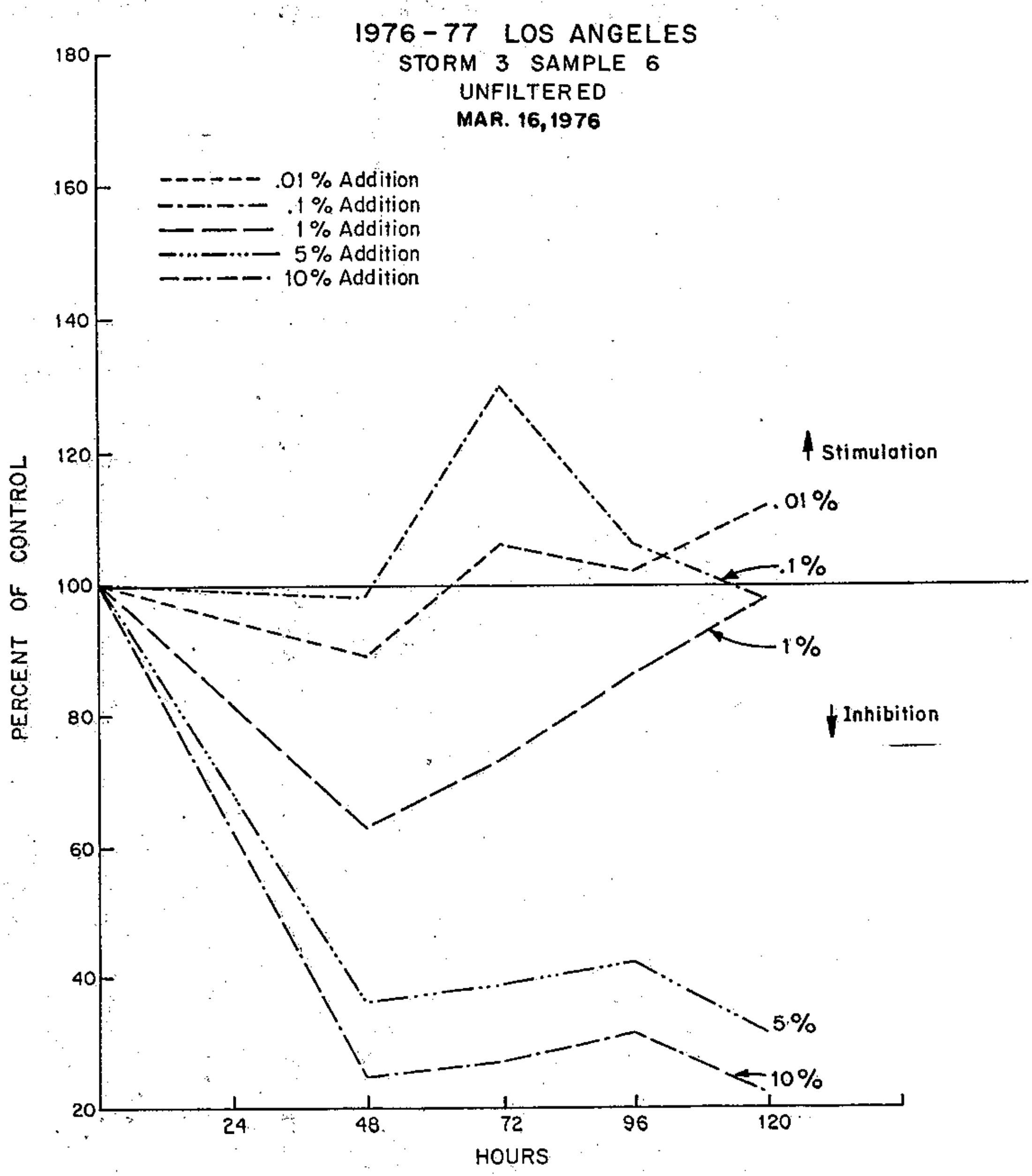

1976 - 77 LOS ANGELES
STORM 3 SAMPLE 2
FILTERED
MAR. 16, 1976
.01 % Addition
.1 % Addition
1 % Addition
5 % Addition
10 % Addition
180
160
140
120
100
80
60
40
20
PERCENT OF CONTROL
Stimulation
.1 %
.01 %
1 %
Inhibition
5 %
10 %
24
48
72
96
120
HOURS

FIGURE 59



1976-77 LOS ANGELES
STORM 3 SAMPLE 6
UNFILTERED
MAR. 16, 1976
.01 % Addition
.1 % Addition
1 % Addition
5 % Addition
10 % Addition
Stimulation
Inhibition
.01 %
.1 %
1 %
5 %
10 %
PERCENT OF CONTROL
HOURS
180
160
140
120
100
80
60
40
20
24
48
72
96
120

FIGURE 60

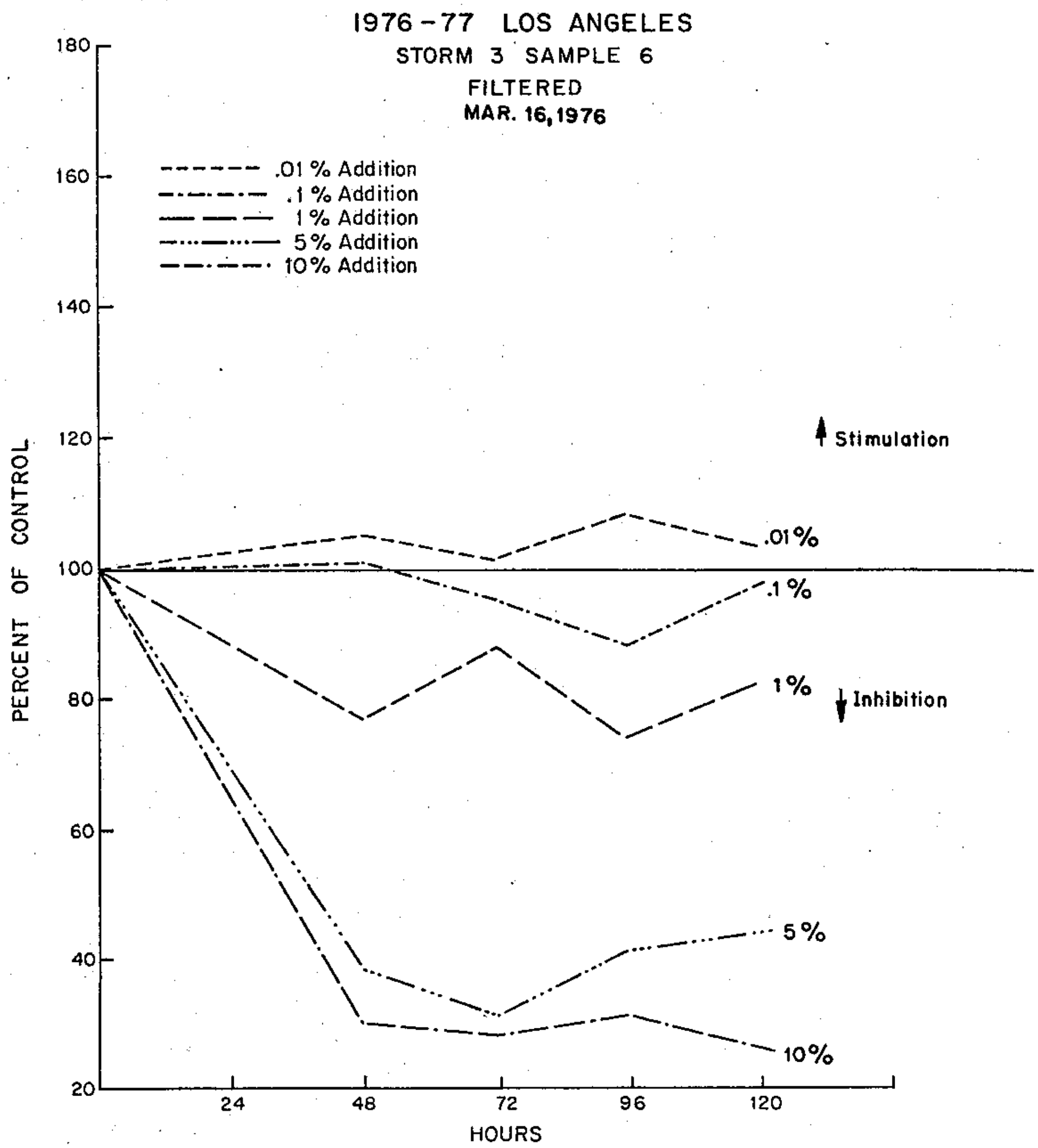

1976-77 LOS ANGELES
STORM 3 SAMPLE 6
FILTERED
MAR. 16, 1976
.01 % Addition
.1 % Addition
1 % Addition
5 % Addition
10 % Addition
Stimulation
Inhibition
.01%
.1%
1%
5%
10%
PERCENT OF CONTROL
180
160
140
120
100
80
60
40
20
24
48
72
96
120
HOURS

FIGURE 61

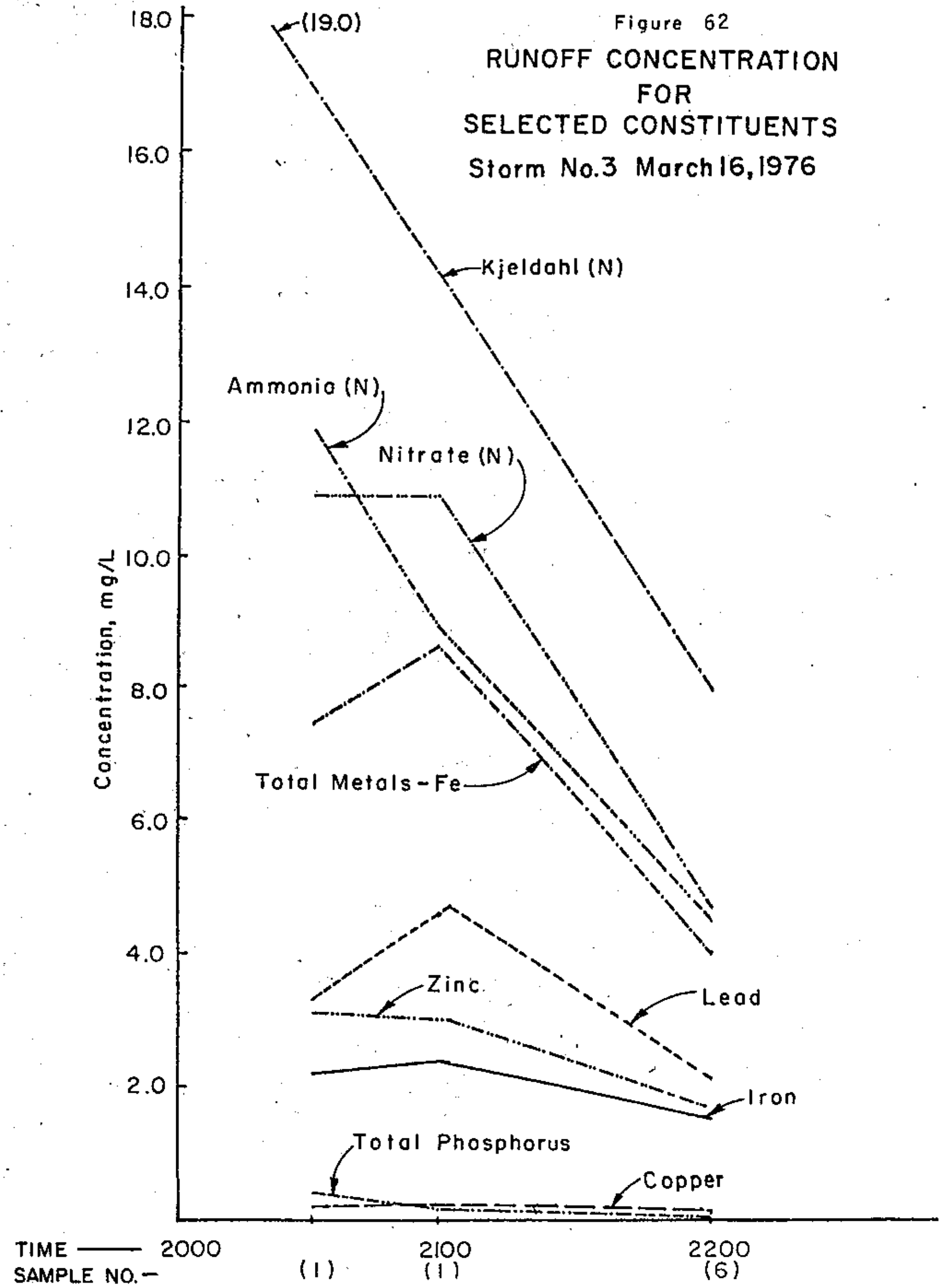


Figure 62
RUNOFF CONCENTRATION
FOR
SELECTED CONSTITUENTS
Storm No.3 March 16, 1976
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
Concentration, mg/L
(19.0)
Kjeldahl (N)
Ammonia (N)
Nitrate (N)
Total Metals - Fe
Zinc
Lead
Iron
Total Phosphorus
Copper
TIME
2000
2100
2200
SAMPLE NO.
(1)
(1)
(6)

TABLE 11

Runoff Concentrations for Selected Chemical Constituents

Los Angeles 1976-77
Storm No. 3 March 16, 1976

	Concentration Mg/l		
Sample Number	1	2	6
METALS			
Iron (Fe)	2.2	2.4	1.5
Total Metals - Fe	7.48	8.71	3.99
Lead (Pb)	3.3	4.7	2.1
Zinc (Zn)	3.1	3.0	1.5
Copper (Cu)	0.13	0.14	0.06
NUTRIENTS			
Nitrate Nitrogen	11.0	11.0	4.7
Kjeldahl Nitrogen	19.0	14.0	7.9
Ammonia Nitrogen	12.0	9.1	4.5
Total Phosphorus	0.40	0.33	0.18
Ortho Phosphate	0.09	0.07	0.02
TOTAL	42.49	34.50	17.30

during this assay run. As with earlier Los Angeles assays, the lower treatments resulted in slight stimulation during the course of the bioassay but returned to parity with the controls prior to the completion of the bioassay.

Figures 59 and 60 show the filtered and unfiltered results of the bioassays of sample 2 respectively. The inhibition exhibited by the 5% and 10% additions is not as dramatic in this sample as in the previous ones. However, it is still significant with productivity decreased from 25-40% of the controls. At the 1% level, Sample 2 (both filtered and unfiltered) was not nearly as inhibitory as sample 1. Additionally, the sample 2 1% treatment differed between filtered and unfiltered. The unfiltered showed a substantial inhibition at the 48-hour point quickly returning to normal, while the filtered was not nearly as dramatic in its inhibitory behavior.

The lower percentage treatment levels in the unfiltered samples acted as in the prior sample, remaining close to the control, with the exception of some stimulation during the middle time periods. The algal growth of filtered sample's lower treatments remained close to the controls. As noted in earlier filtered vs. filtered assays, the filtering procedure did not remove the serious inhibiting constituents but did tend to reduce the severity of the algae response especially in the lower addition levels.

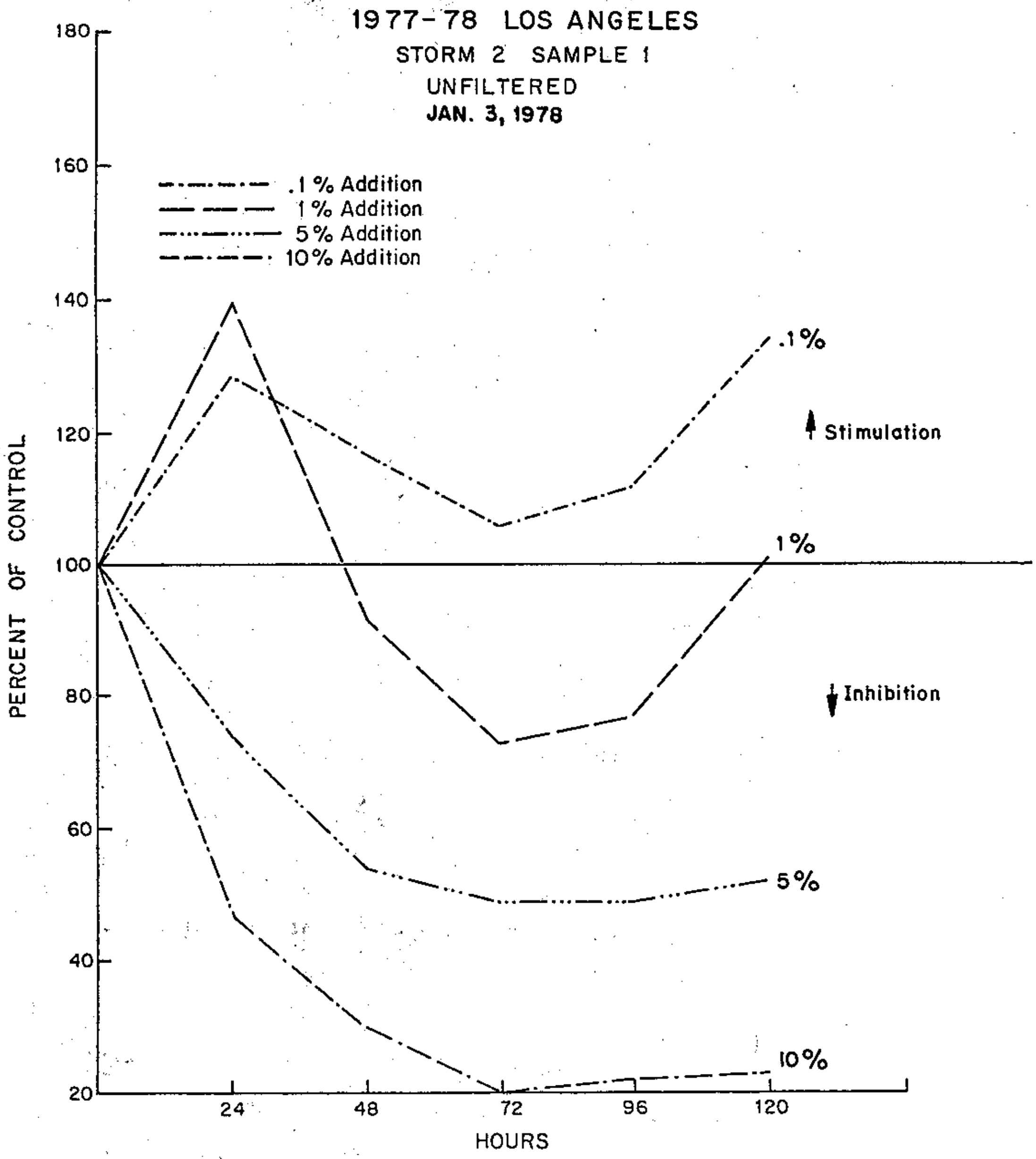
Sample 6 (Figures 60 and 61) again shows the effects of filtering which is essentially a condensing of the algal responses to lower levels of runoff pollutants. The filtered results are more uniform and do not fluctuate as much as unfiltered samples. Although sample 6 contains considerably fewer pollutants (Table 11) the 5% and 10% treatments were again significantly inhibitory. At these levels, in the prior Los Angeles bioassays, there was little difference in the algal response between filtered and unfiltered samples.

Figures 63-65 shows bioassay results from three samples taken during the second storm (January 3, 1978) (samples 1, 5, 9) in the Los Angeles area during the 1977-78 winter. This storm occurred five days after previous rains. The concentration of chemical constituents noted in Figure 66 was assayed using filtered and unfiltered treatments.

Due to economic considerations these bioassays were sub-sampled at 24-, 72-, and 120-hours intervals rather than the previous 24-hour regime.

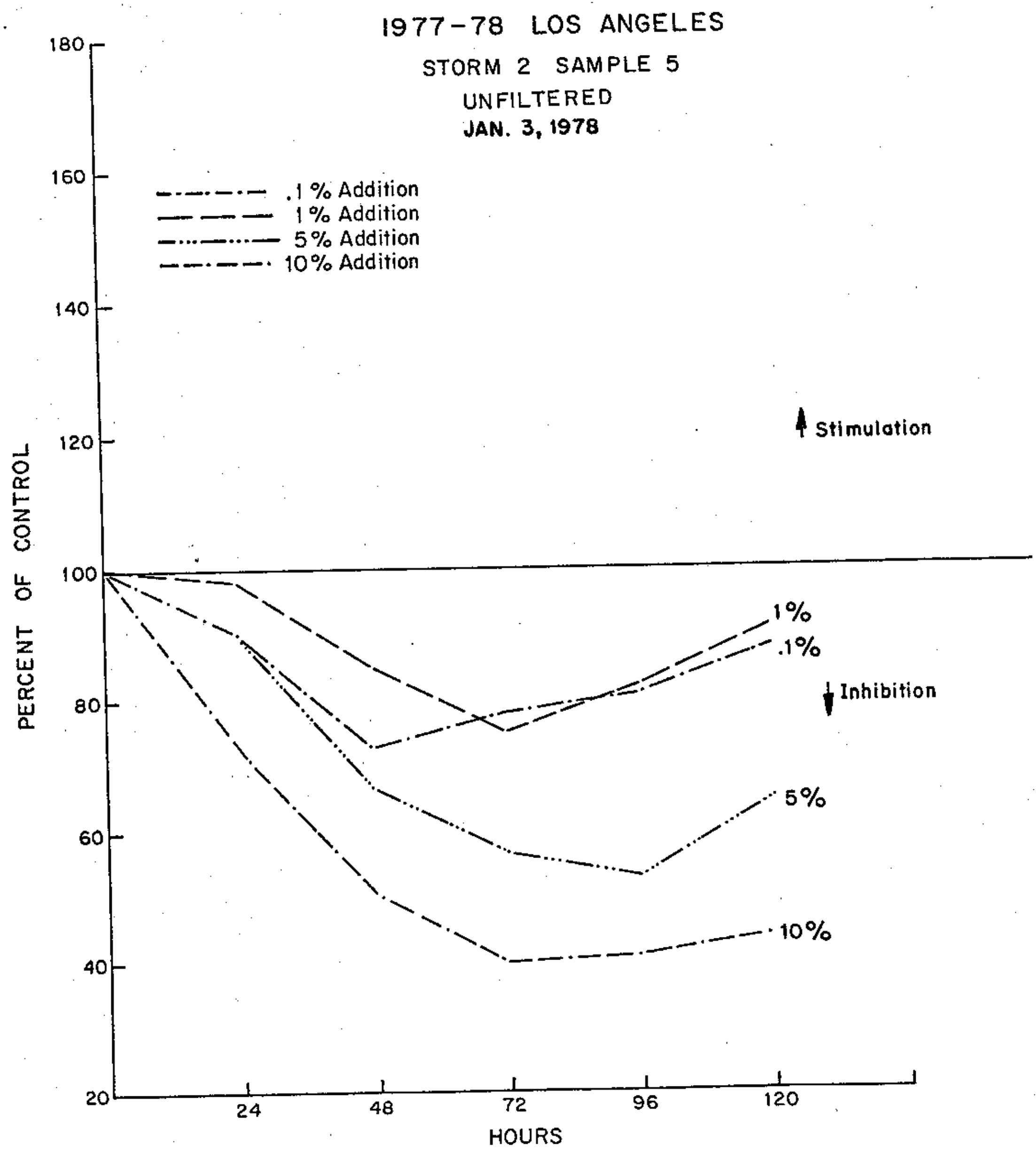
Figure 63 shows the bioassay results from sample 1 which had the highest concentrations of contaminants of the samples bioassayed. The 5% treatment resulted in a substantial lowering of algal productivity compared to the controls. The 10% additions resulted in even more significant inhibition, lowering algal productivity to as low as 20% of the controls. The lower levels were initially stimulatory with the 1% addition assays behaving erratically but terminating at parity with the controls. The .1% addition assays remained slightly stimulatory and terminated just at the significance level.

Figures 64 and 65 are the results of bioassays on samples 5 and 9. The sample 5 bioassay showed the 5% and 10%



1977-78 LOS ANGELES
STORM 2 SAMPLE 1
UNFILTERED
JAN. 3, 1978
.1 % Addition
1 % Addition
5 % Addition
10 % Addition
.1%
1%
5%
10%
Stimulation
Inhibition
PERCENT OF CONTROL
180
160
140
120
100
80
60
40
20
24
48
72
96
120
HOURS

FIGURE 63



1977-78 LOS ANGELES
STORM 2 SAMPLE 5
UNFILTERED
JAN. 3, 1978
.1 % Addition
1 % Addition
5 % Addition
10 % Addition
Stimulation
Inhibition
PERCENT OF CONTROL
HOURS
1%
.1%
5%
10%
180
160
140
120
100
80
60
40
20
24
48
72
96
120

FIGURE 64

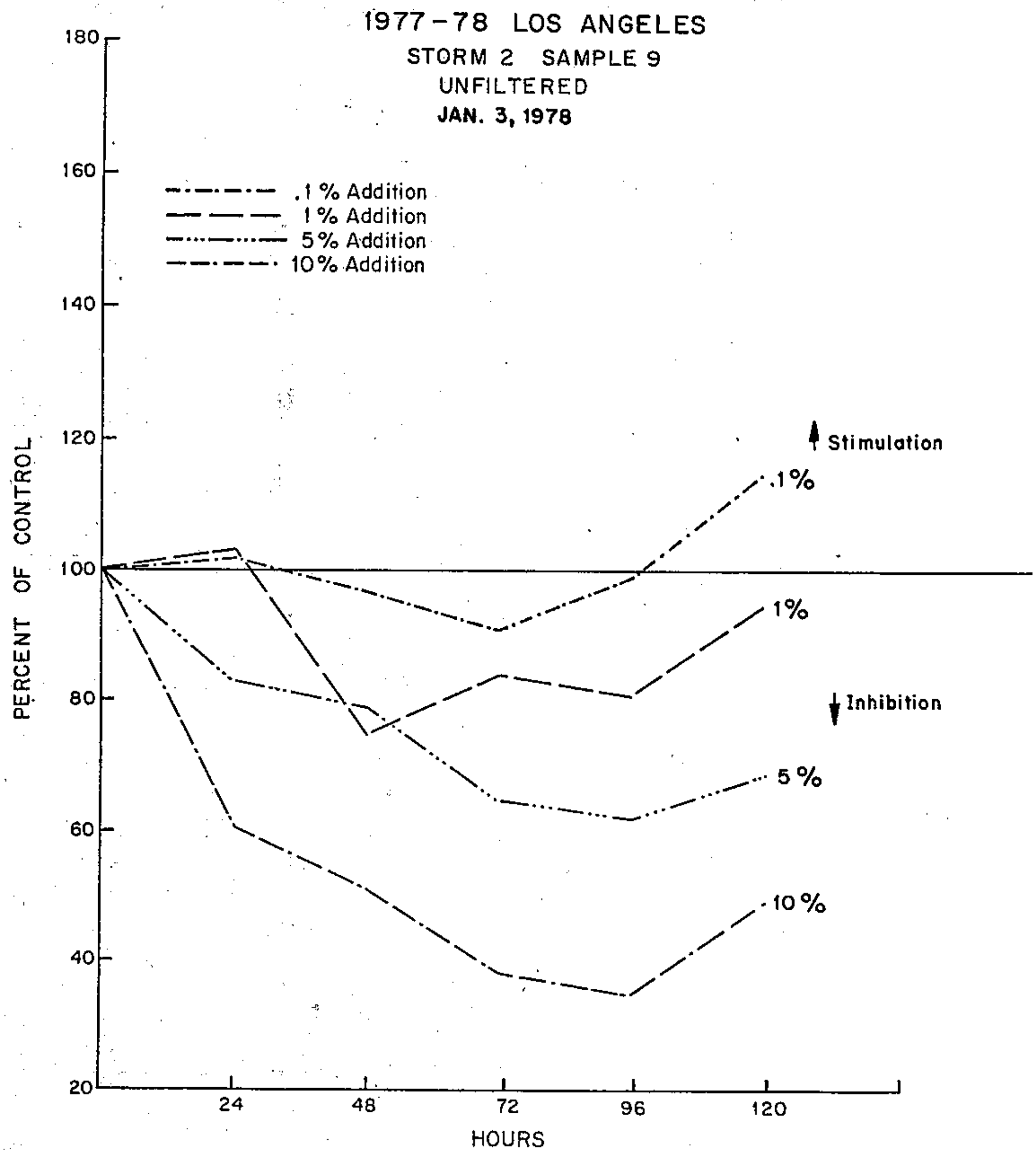

1977-78 LOS ANGELES
STORM 2 SAMPLE 9
UNFILTERED
JAN. 3, 1978
.1 % Addition
1 % Addition
5 % Addition
10 % Addition
Stimulation
Inhibition
.1%
1%
5%
10%
PERCENT OF CONTROL
180
160
140
120
100
80
60
40
20
24
48
72
96
120
HOURS

FIGURE 65

Figure 66

RUNOFF CONCENTRATION
FOR
SELECTED CONSTITUENTS

Los Angeles 1977-78
Storm No.2 Jan.3,1978

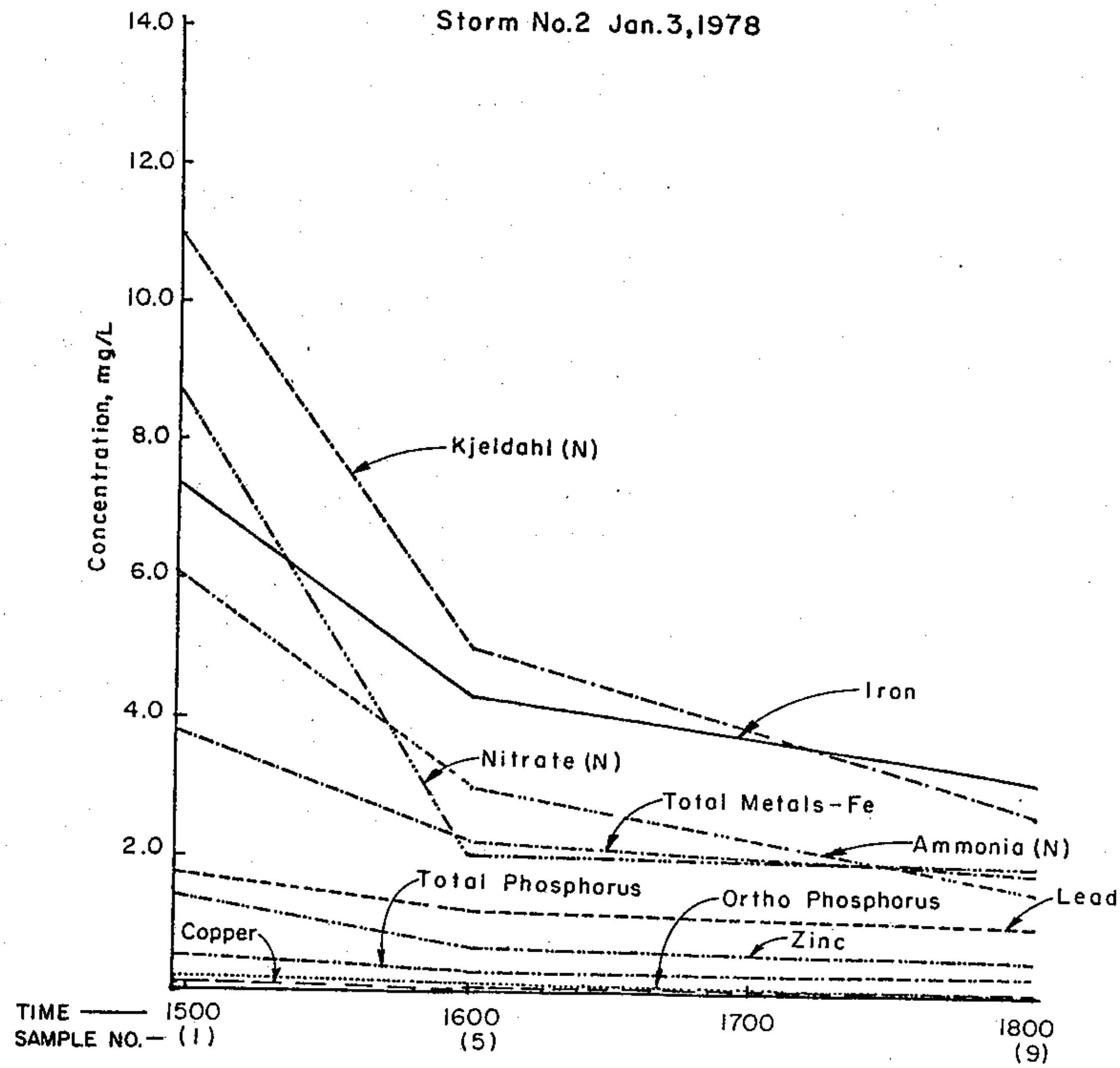


TABLE 12

Runoff Concentrations for Selected Chemical Constituents

Los Angeles 1977-78
Storm No. 2 Jan. 3, 1978

	Concentration Mg/l		
Sample Number	143	187	151
METALS			
Iron (Fe)	7.4	7.3	3.1
Total Metals - Fe	3.8	2.18	1.78
Lead (Pb)	1.7	1.2	1.0
Zinc (Zn)	1.44	0.72	0.59
Copper (Cu)	0.14	0.07	0.05
NUTRIENTS			
Nitrate Nitrogen	8.8	2.0	1.9
Kjeldahl Nitrogen	11.3	5.0	2.6
Ammonia Nitrogen	6.1	3.0	1.5
Total Phosphorus	0.49	0.27	0.23
Ortho Phosphate	0.21	0.10	0.04
TOTAL	26.90	10.37	6.27

additions causing substantial inhibition but not as severe as previous Los Angeles samples. The lower treatments (.1%, 1%) appear mildly inhibitory but within limits of the controls. Sample 9 results in substantial inhibition at the 10% level, less at the 5% and relatively minor fluction at the lower levels.

Figure 63 shows the bioassay results from sample 1 which had the highest concentrations of contaminants of the samples bioassayed. The 5% treatment resulted in a substantial lowering of algal productivity compared to the controls. The 10% additions resulted in even more significant inhibition, lowering algal productivity to as low as 20% of the controls. The lower levels were initially stimulatory with the 1% addition assays behaving erratically but terminating at parity with the controls. The .1% addition assays remained slightly stimulatory and terminated just at the significance level.

Figures 64 and 65 are the results of bioassays on samples 5 and 9. The sample 5 bioassay showed the 5% and 10% additions causing substantial inhibition but not as severe as previous Los Angeles samples. The lower treatments (.1%, 1%) appear mildly inhibitory but within limits of the controls. Sample 9 results in substantial inhibition at the 10% level, less at the 5% and relatively minor fluction at the lower levels.

SLOPES

The heavy rains which developed during the 1977-78 winter allowed the first real opportunity to sample cut slope runoff reasonably close to Sacramento insuring

successful sampling.
Chemical data for the slope samples are shown in the Appendix (page 160) Parameters are the same as those analyzed for the roadway runoff with the exception of some metals, oil and grease, total solids, dissolved oxygen and pH. Laboratory pH is noted. Flow data were not secured for the limited slope runoff sampling conducted.

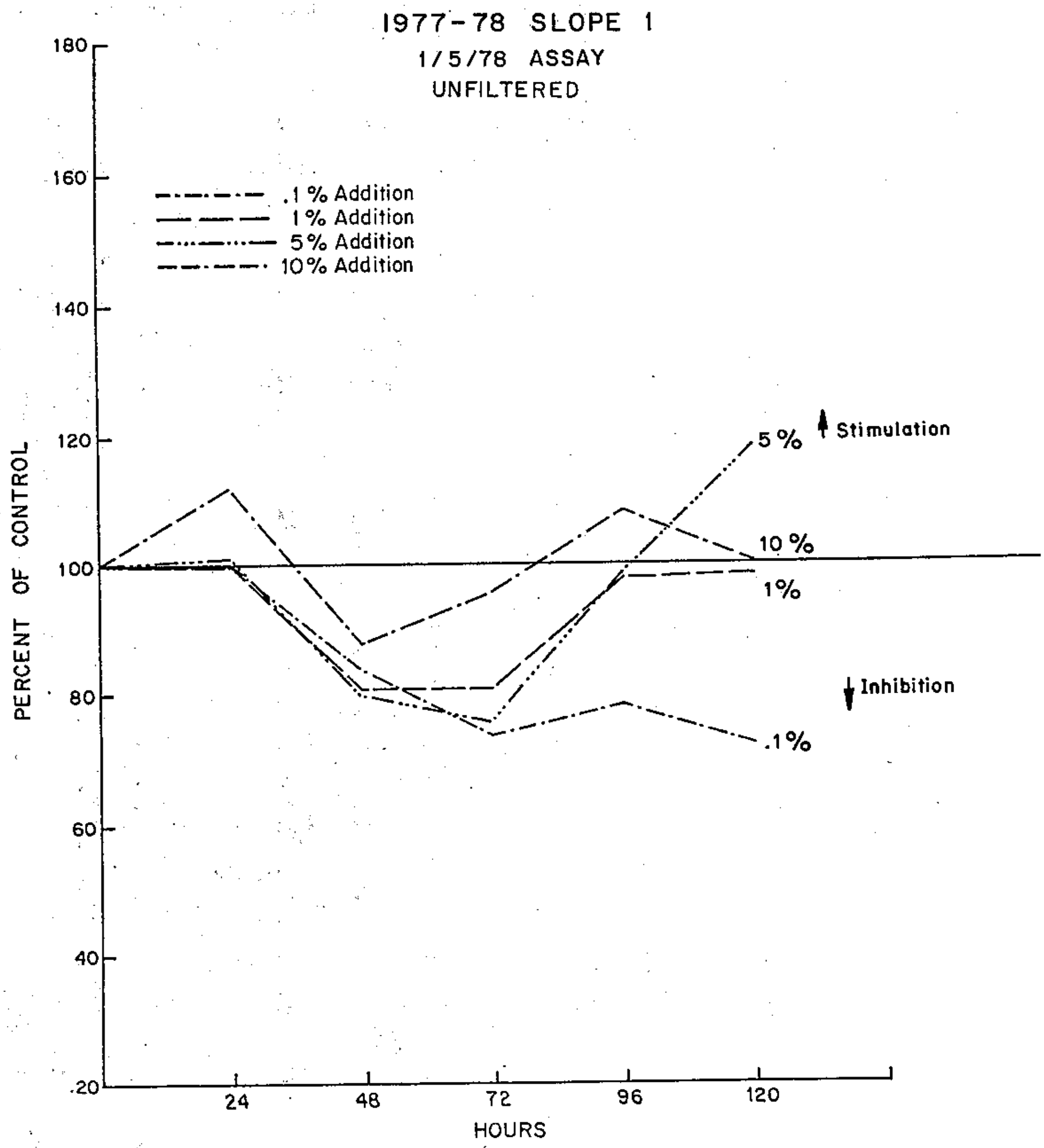
Figures 67 and 68 show the results of bioassays run on slope runoff for the storm sampled on January 5, 1978.

Slope 1 runoff seemed to have little effect on algae productivity. Basically these treatments results in some fluctuations of productivity but they remained within control limits. Figure 68 shows the slope e results which contrast markedly with Slope 1 slope results. With the exception of the .1% additions the various treatments were stimulatory terminating on day 5 approximately 50% above the controls.

The chemical analyses indicate considerably more nutrients are present in Slope 2 runoff and this probably accounts for the stimulatory nature of the runoff. The Slope 2 sampling point lies adjacent to and at approximately the same elevation as the highway for much of its drainage course. The high lead level analyzed indicate the site probably is dusted with lead as it settles from highway traffic (8). In contrast, Slope 1 runoff is gathered from well above the highway where exhaust fumes do not reach and particulate lead does not accumulate.

Figure 69 and 72 are the results of the unfiltered and filtered assays on the January 14, 1978 storm slope runoff from Slope 1 and 2 respectively. The unfiltered assay run for Slope 1 was unusual in that the runoff cause an increasing inhibition of the algal productivity at all treatment levels. The chemical analysis of this sample does not indicate the cause for this result. Suspended sediment load may have been the cause of the inhibition in the unfiltered sample. Increased turbidity decreases the light available for photosythesis. When the filtered sample was assayed, the algae exhibited fluctuations in productivity, demonstrated little inhibition and was relatively unaffected by the various treatments.

The January 14, 1978, Slope 2 bioassays contrasted with previous bioassays performed on runoff from this site (January 5, 1978). Both the unfiltered and filtered bioassay from the January 14, 1978 storm were not stimulatory. The unfiltered bioassay showed some inhibition at 72 hours, but recovered during the latter phase of the bioassay. The filtered run was somewhat muted in its response, but the overall effect of the runoff on algal productivity was insignificant. The chemical results do not indicate substantial differences between the two sample periods with the exception that lead which was higher in the January 14, 1978 runoff.



1977-78 SLOPE 1
1/5/78 ASSAY
UNFILTERED
.1 % Addition
1 % Addition
5 % Addition
10 % Addition
5 %
Stimulation
10 %
1%
Inhibition
.1%
PERCENT OF CONTROL
180
160
140
120
100
80
60
40
.20
24
48
72
96
120
HOURS

FIGURE 67

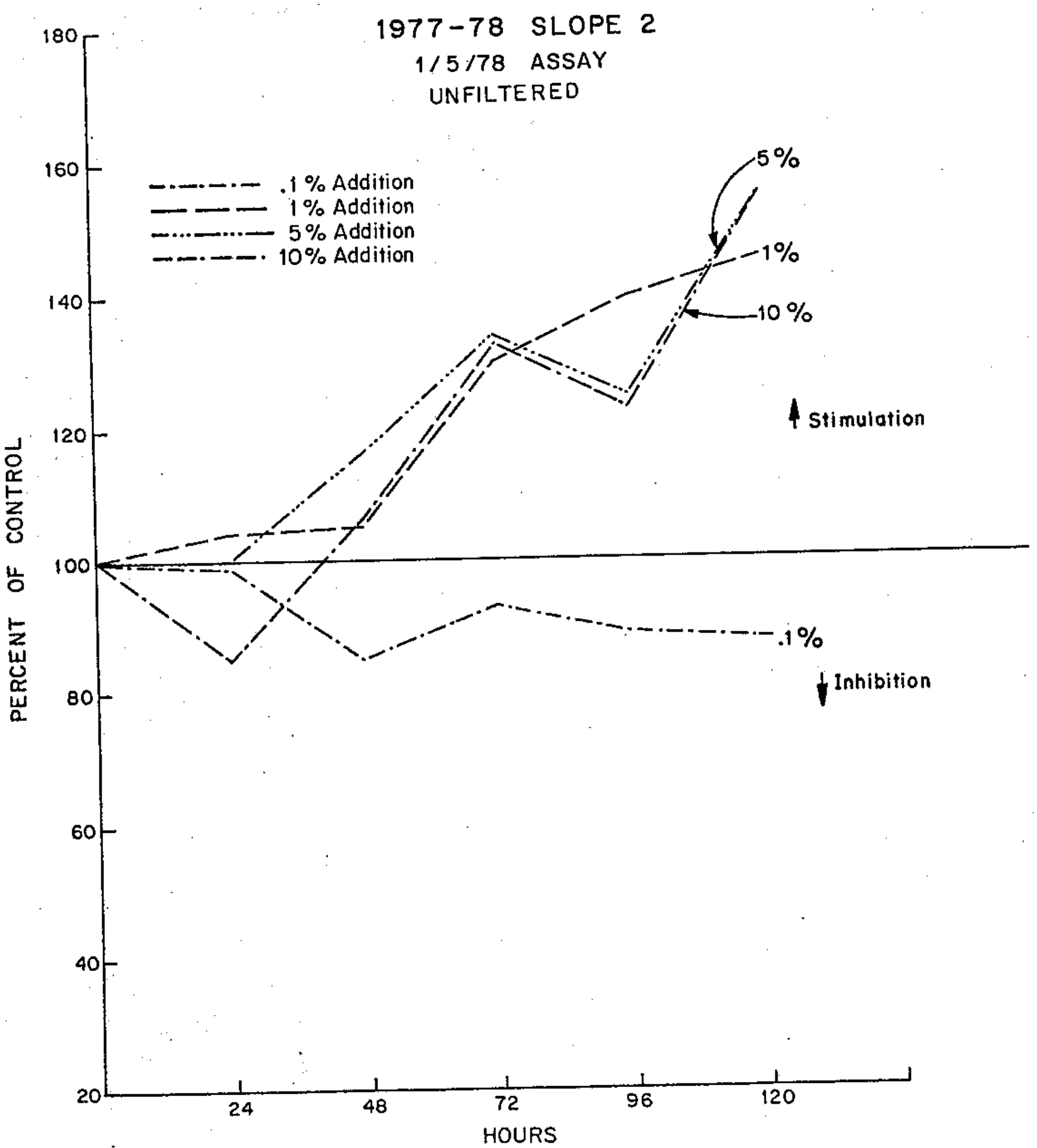

1977-78 SLOPE 2
1/5/78 ASSAY
UNFILTERED
.1 % Addition
1 % Addition
5 % Addition
10 % Addition
5 %
1 %
10 %
.1 %
Stimulation
Inhibition
PERCENT OF CONTROL
180
160
140
120
100
80
60
40
20
24
48
72
96
120
HOURS

FIGURE 68

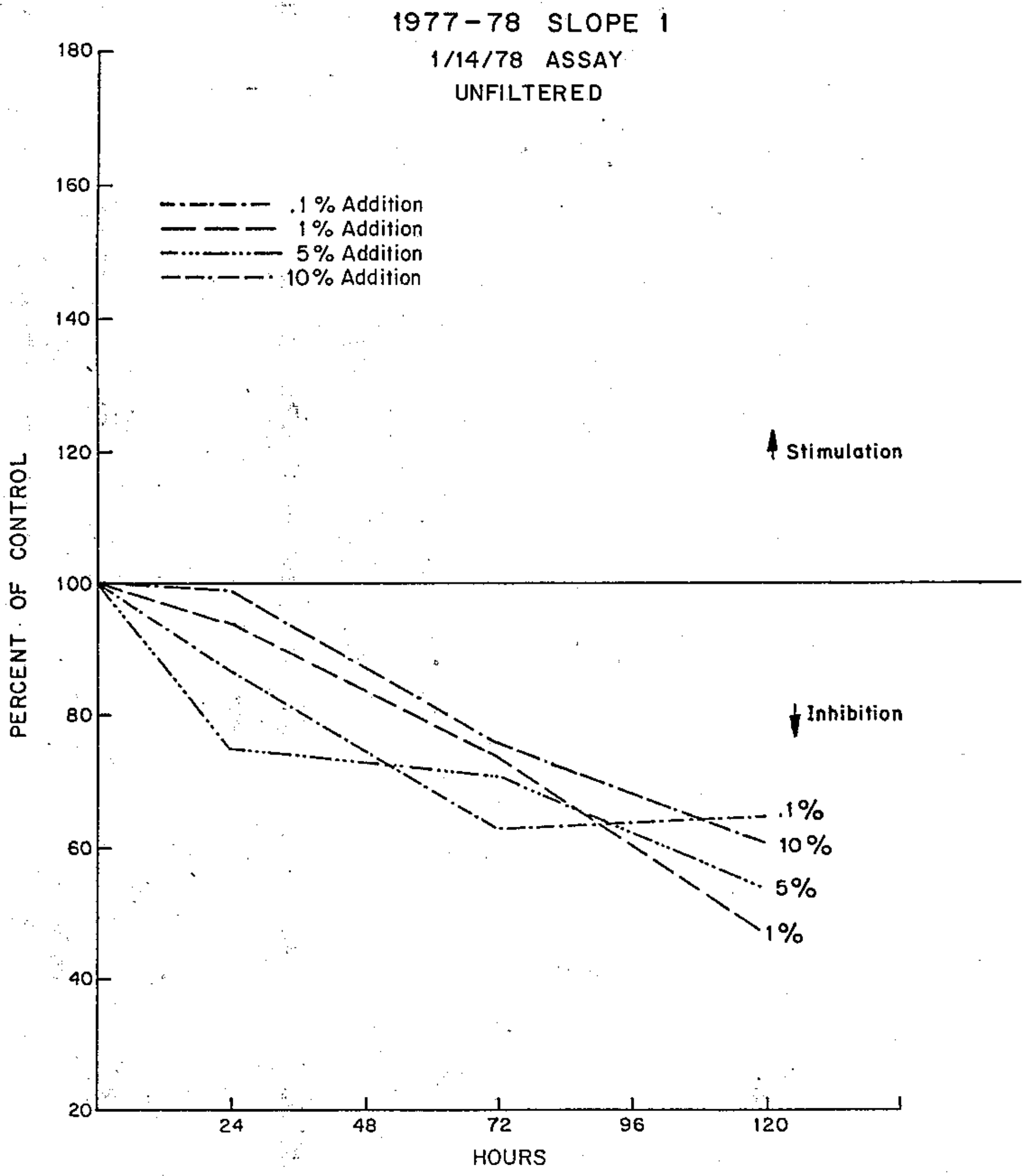
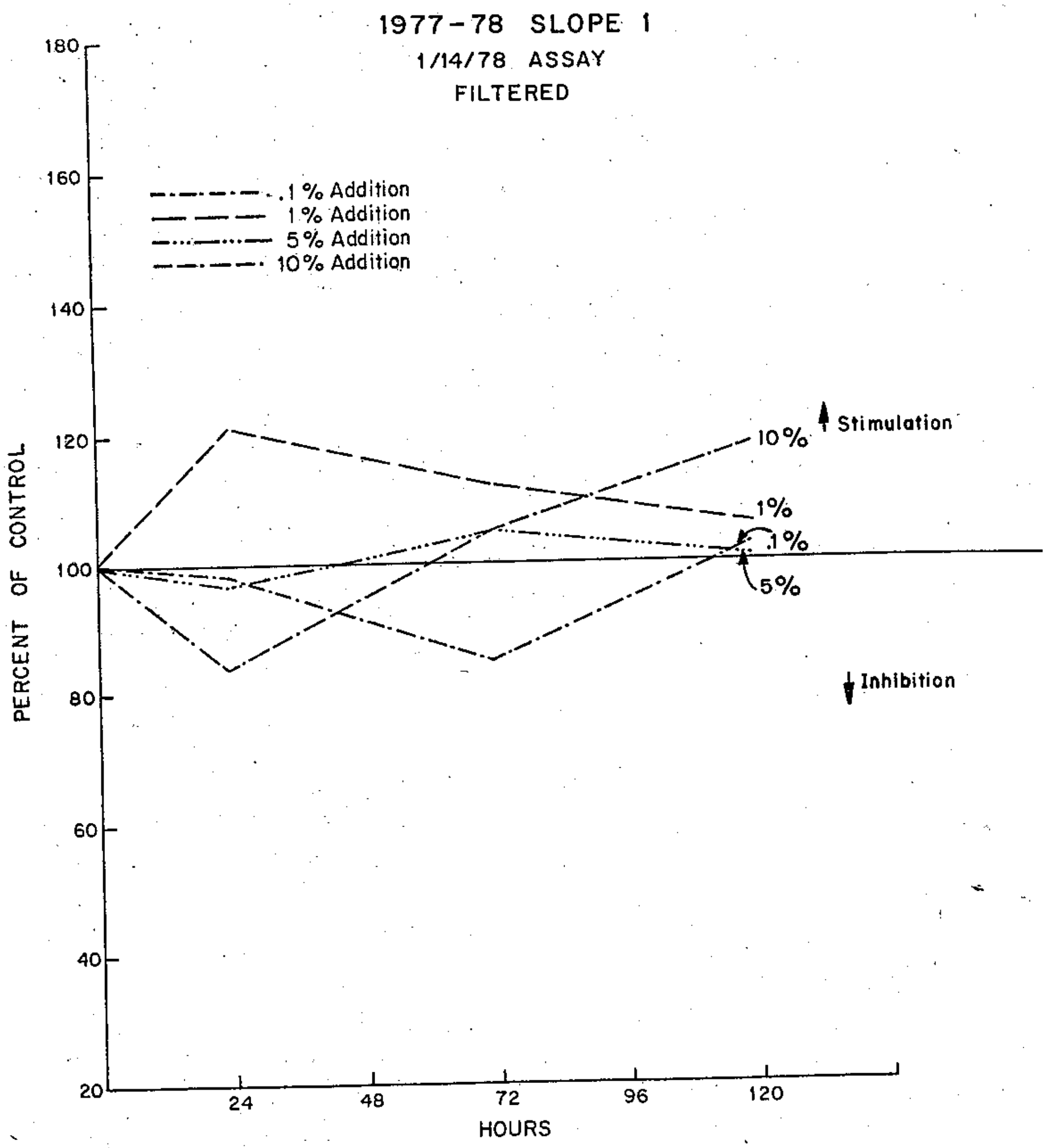
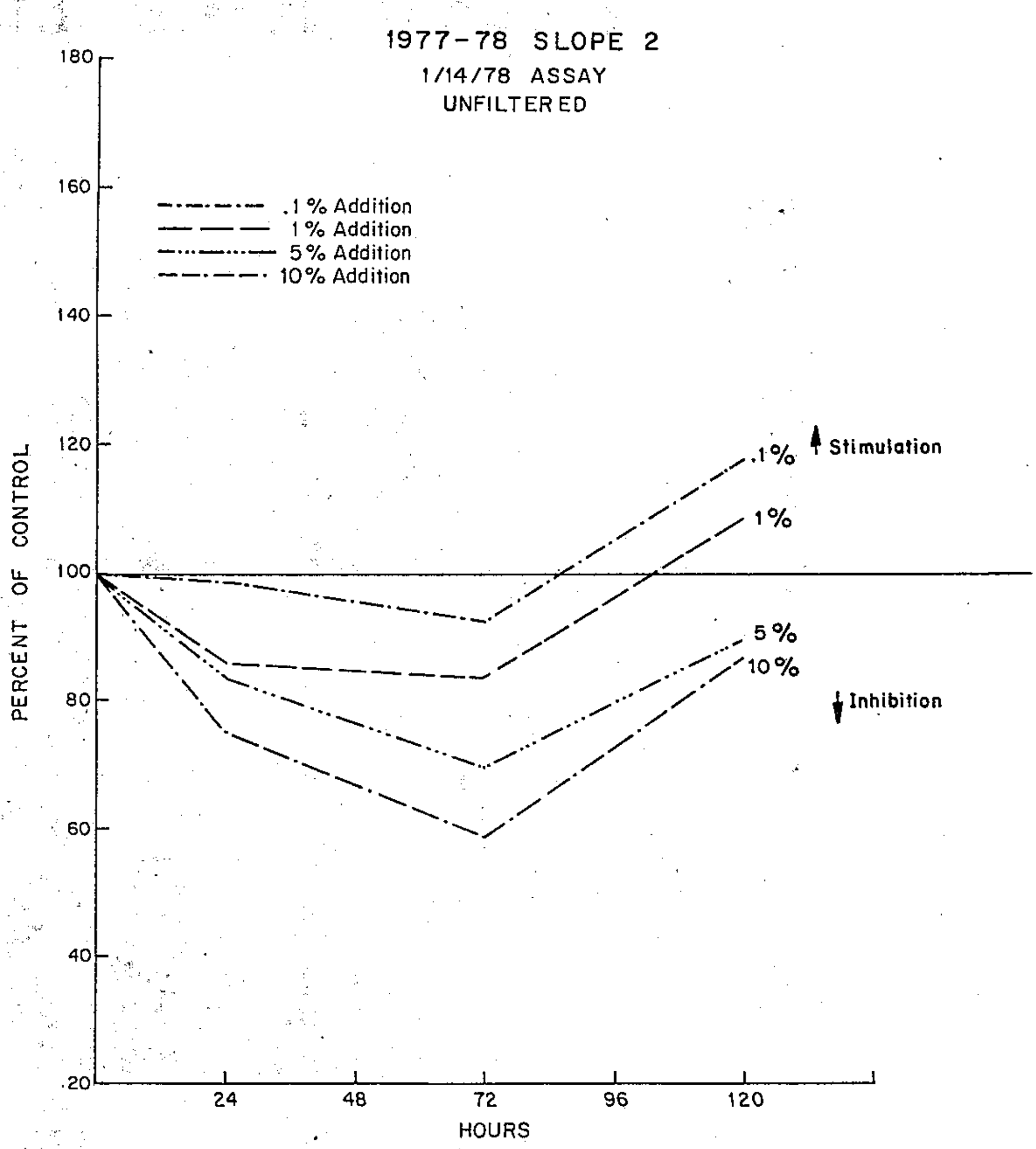

1977-78 SLOPE 1
1/14/78 ASSAY
UNFILTERED
.1 % Addition
1 % Addition
5 % Addition
10 % Addition
PERCENT OF CONTROL
180
160
140
120
100
80
60
40
20
24
48
72
96
120
HOURS
Stimulation
Inhibition
.1%
10%
5%
1%

FIGURE 69



1977-78 SLOPE 1
1/14/78 ASSAY
FILTERED
.1 % Addition
1 % Addition
5 % Addition
10 % Addition
Stimulation
Inhibition
10%
1%
.1%
5%
PERCENT OF CONTROL
180
160
140
120
100
80
60
40
20
24
48
72
96
120
HOURS

FIGURE 70



1977-78 SLOPE 2
1/14/78 ASSAY
UNFILTERED
.1 % Addition
1 % Addition
5 % Addition
10 % Addition
180
160
140
120
100
80
60
40
20
PERCENT OF CONTROL
24
48
72
96
120
HOURS
.1%
1%
5%
10%
Stimulation
Inhibition

FIGURE 71

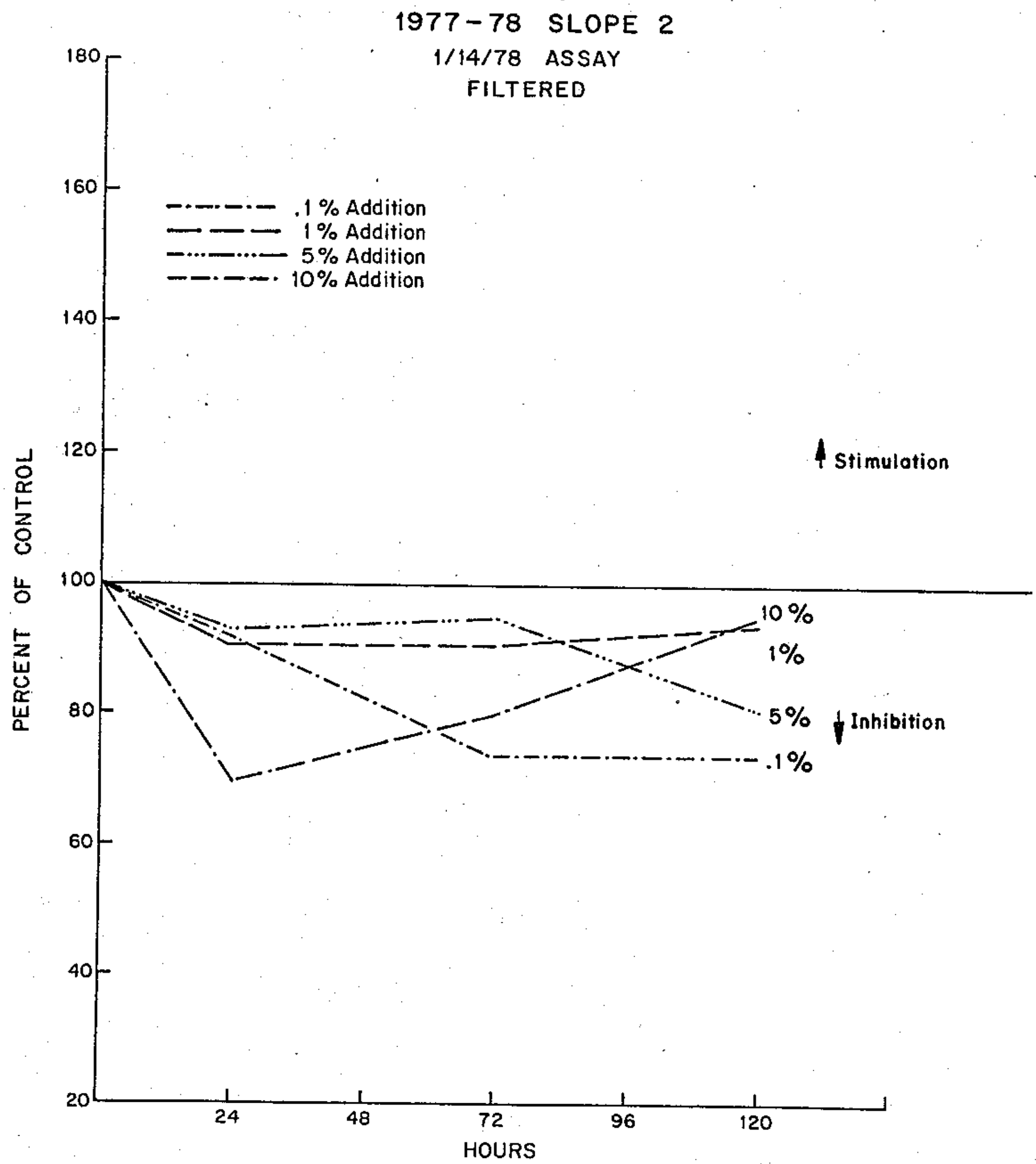

1977-78 SLOPE 2
1/14/78 ASSAY
FILTERED
.1 % Addition
1 % Addition
5% Addition
10% Addition
180
160
140
120
100
80
60
40
20
PERCENT OF CONTROL
24
48
72
96
120
HOURS
10 %
1%
5%
.1%
Stimulation
Inhibition

FIGURE 72

Discussion of Bioassay Results

During this study, California experienced unusual weather. The 1975-77 winters resulted in a record drought which was followed by an abormally wet winter 1977-78. Due to the abnormal winter conditions, which prevailed during the research period, it is not known if the research results represent normal California winter conditions.

Weather during the project could be interpreted as extremes of the normal expected rainfall. Bioassay results during the drought years are similiar to those for the wet 1977-78 winter. Therefore, it is felt the assays probably give a good estimate of what could be expected during normal precipitation.

The results of the bioassays are related to the contaminant levels of roadway runoff. Contaminant concentration are not so much related to yearly rainfall but rather to other factors such as intensity of rain, length of time between storm events, average daily traffic and other factors relating to the accumulation of roadway pollutants. It does appear that yearly rainfall (amount, duration and intensity) and the pollutant accumulation are important in determining the overall effects of runoff on the aquatic environment.

While correlations were not made during this study or the concurrent research project A-8-20, "Water Pollution Aspects of Particles Which Collect on Highway Surfaces"s" (3), it appears from the chemical results (Appendix A) that the most significant concentrations of roadway runoff contaminants occur when there has been a substantial dry period between storms. The A-8-20 chemical data is currently being analyzed with the dry period-contaminant accumulation aspect receiving further study.

Within a storm event, depending on the intensity of rainfall, there normally is a higher load of contaminants in the initial samples followed by a declaine of contaminants concentration. This results from the flushing of the roadway surface as the storm progresses. Some samples other than those taken early in a runoff event may have higher contaminant loads, for example the December 29-30 storm. This may be as a result of increased rain intensity and increased washing of contaminants off the roadway surface.

For the example, the first sample of the second Placerville storm in 1976-77 winter (February 8, 1977). which followed 27 dry days after a previous low intensity storm, shows total metals minus iron in excess of 33 mg/L (Table 3) and nutrients exceeding 31 mg/L. By the end of the storm, the total metal minus iron content was down to 4.5 mg/L while nutrients and dropped to 2.9 mg/L.

The Los Angeles December 30, 1976 storm sampled, following a 46-day dry period, exhibits this same trend. Metals dropped from 32.8 mg/L to approximately 7.1 mg/L and nutrients from 44.8 mg/L to 7.9 mg/L (Table 9).

In contrast, a Walnut Creek storm (October 1, 1976) sampled only 3 days after a prior event showed metals remaining fairly constant at about 7 mg/L while nutrients were reduced somewhat. Additionally, the January 5, 1977, Los Angeles storm, which was sampled two days after a previous wet period, contained the lowest contaminant levels recorded for any Los Angeles storm sampled.

The results of the bioassays show a correlation with the concentration of runoff contaminants. When the concentration of runoff contaminants is fairly heavy, such as the first samples in an event, inhibition of algal productivity is evident. Various storm samples assayed had responses paralleling the changes in contaminant levels from start of storm to finish. For example, the first sample from the Placerville storm (February 8, 1977) was high in runoff contaminants, expecially metals, and generally inhibited algal production. Sample 2 and 6 from this sotrm contained considerably fewer contaminants and were not as inhibitory. The lower additions of pavement runoff water to the lake water were somewhat stimulatory.

In the December 29-30, 1976 Walnut creek storm, the first sample was metal levels at about 11 mg/L and approximately 64 mg/L nutrients. In this case there was inhibition at the 10% treatment, but it appears the lower treatments did not contain sufficient metals to be inhibitory. Perhaps the relatively high levels of nutrients were adequate to offset any inhibiting effects at these levels since there was an increase in productivity. The middle runoff samples show generally what the first sample showed with less inhibition. Sample 15, with higher contaminant levels, indicates a downturn of the growth rate compared to the middle samples.

period between storms which allows accumulation of materials. The 657117 chemical data is currently being analyzed with the dry period/accumulation aspect receiving further study.

Additionally, within a storm event, and depending on the intensity of rainfall, there normally is a higher load of contaminants in the first few samples followed by a decline of contaminant concentration, resulting from flushing of the roadway surface, as the storm progresses. However, within this overall trend some samples other than the early ones may have higher contaminant loads and this is a result of increased rain intensity and its consequent increased washing of contaminants off the roadway surface.

For example, the first sample of the second Placerville storm in 1976-77 winter (Feb. 8, 1977) which followed 27 days of dry weather after previous low intensity storm, shows total metals minus iron in excess of 33 mg/L (Table 3) and nutrients exceeding 31 mg/L. By the end of the storm, the total metal minus iron content was down to approximately 4.5 mg/L while nutrients had dropped to 2.9 mg/L.

The Los Angeles storm sampled Dec. 30, 1976, after a 46 day dry period, exhibits this same trend. Metals dropped from 32.8 mg/L to approximately 7.1 mg/L and nutrients from 44.8 mg/L to 6.9 mg/L during the course of the storm (Table 9).

In contrast, a Walnut Creek storm was sampled only 3 days after a prior event and shows metals staying fairly constant at about 7 mg/L while nutrients were reduced somewhat. Additionally, the January 5, 1977 Los Angeles storm which was sampled 2 days after a previous wet period contained the lowest contaminant levels recorded for any Los Angeles storm sampled.

The results of the bioassays show a correlation with the concentration of runoff contaminants. It is apparent when the concentration of runoff contaminants is fairly heavy, such as the first couple of samples in an event, inhibition of algal productivity is evident. Various storm samples assayed had responses paralleling the changes in contaminant levels from start of storm to finish. For example, the first sample from the Placerville storm (Feb. 8, 1977) was high in runoff contaminants, especially metals, and generally inhibited a algal production. Samples 2 and 6 from this storm contained considerably fewer contaminants, were not inhibitory to the extent of the first sample. The lower additions of pavement runoff water to the Lake water were somewhat stimulatory.

The Dec. 29-30, 1976 Walnut Creek storm the first sample had metal levels at about 11 mg/L and approximately 64 mg/L nutrients. In this case there was inhibition at the 10% treatment, but it appears the lower treatments did not contain sufficient metals to be inhibitory. Perhaps the relatively high levels of nutrients were adequate to offset any inhibiting effects at these levels since there was an increase in productivity. The middle samples show generally what the first sample showed with less inhibition, but sample 15, with higher contaminant levels, indicates a downturn of the growth rate compared to the middle samples.

In contrast to the relatively high contaminant levels which accumulated on roadways during dry periods and the restulting inhibitory characteristics, numerous storms were sampled within a few days of previous rain events and they usually had lower contaminant levels as well as generally stimulatory assay results.

The March 16, 1977 Placerville storm, the Oct. 1, 1976, Walnut Creek storm, the Nov. 21, 1977 Walnut Creek storm, and the Jan 5, 1977 Los Angeles storm all show relatively high stimulation during assays. All these storms were sampled within a few days of previous storms with the exception of the Nov. 21, 1977 Walnut Creek storm which had a 15 day interval,. During this latter period, however, there was sufficient wet weather to prevent the accumulation of contaminants.

The effects of runoff on algal cultures is dramatically apparent in most of the Los Angeles assays. For example, the Los Angeles storm of March 16, 1976 (Storm 3, samples 1, 2, 5) sampled after 13 days of dry weather, shows extreme inhibition of algal productivity at the 1%, 5% and 10% levels, especially in the first sample. Samples 2 and 6 show serious inhibition at the 5% and 10% levels with sporadic inhibition at the 1% treatment level. All of the LA assays showed significant inhibition of algal productivity.

It is interesting to note that in most assays which resulted in significant inhibition, there was a relatively high level of heavy metals (lead, zinc) (85-95%) when compared to the total metals minus iron. Numerous assays, (Placerville No. 3 on March 16, 1977, Walnut

Creek No. 3, Dec. 29-30, 1976, Walnut Creek No. 2, Nov. 21, 1977) show relatively high levels of these metals and were not extremely inhibitory to algal growth. In these cases, the heavy metal portion of the metal minus iron contaminants were usually below 80%.

It is apparent from the assay results and statistical evaluations that the concentration of constituents in the runoff can have a significant impact on algal productivity. Determining what constituents, at what concentrations, and to what extent synergistic action between constituents becomes detrimental to algal productivity was not within the scope of this study but must be investigated to fully understand road runoff effects on algal productivity.

With the migitation of possible runoff impacts on algal productivity in mind, both filtered and unfiltered samples were assayed. The results of the filtered and nonfiltered assays indicate there is no significant differences in assay response between filtered and unfiltered samples. It is apparent the removal of particulate materials from the roadway runoff is not sufficient to reduce significantly the effects of deleterious runoff on algal productivity. It should be noted the filtering of the samples merely represents the physical removal of particulate materials from the runoff. The physical filtering does not allow an evaluation of the filtering and biological breakdown of highway runoff via a marsh or vegetative pond environment. The biological breakdown or utilization of the roadway runoff contaminants may be an effective measure employed to detority deleterious components. The effect of filtering versus nonfiltering of cut slope runoff was not apparent due to the limited amount of assaying conducted on slope runoff.

Due to insufficient rainfall during the first years of this project, only minimal sampling of slope runoff was conducted. The Jan. 5, 1978 assays on slope 1 indicate no significant effects of this runoff on algal productivity. In contrast, the Slope 2 assay was relatively stimulatory and is probably due to the higher nutrient levels. It is interesting to note the lead levels were relatively high in Slope 2 runoff, but lead was the only heavy metal analyzed and consequently conclusions cannot be made.

The Jan. 14, 1978 assays of slope runoff samples indicate relatively little effects on algal productivity. The exception to this was the case where the results from the Slope 1 unfiltered which caused substantial inhibition of algal productivity. Review of the chemical data does not indicate the reason. Due to the diverse conditions on slopes throughout California, considerably more assays and slope sampling will be necessary to delineate the effects of slope runoff on algal productivity.

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8. "A Study of the Influence of Highway Deicing Agents on the Aquatic Environment in the Lake Tahoe Basin and Drainages Along Interstate 80," C. R. Goldman and R. W. Hoffman, Ecological Research Associates, Caltrans Report CA-DOT-TL-7153-1-75-27-19-4134.

APPENDIX A

Chemical Analyses of Roadway and Slope Runoff

PLACERVILLE 1976-77

PROJECT LOCATION Placerville DIST. 03 CO. ED RTE. 50 P.M. 15.5

PARAMETER	DATE 2/8/77				STORM NO. 2					
SAMPLE NO.	1	2	3	4	5	6	7	8	9	10
TIME (PST)	0942	0957	1015	1030	1045	1100	1125	1210	1510	1525
FIELD										
Flow, cfs	0.23	0.02	0.003	0.003	0.02	0.003	0.0007	< 0.0003	0.23	0.30
Temp, °C	9.2	10.7	9.4	9.7	9.7	10.0	10.9	9.2	9.2	9.0
Cond, µmhos/cm	500	218	259	292	202	179	207	289	106	71
pH	6.5	6.7	6.9	7.0	7.1	7.6	7.2	7.2	6.7	7.2
D.O. mg/l	–	–	–	–	–	–	–	–	–	–
MAJOR IONS										
B mg/l	0.24	0.17	0.17	0.18	0.16	0.12	0.15	0.18	0.06	0.05
Ca mg/l	78	16	15	15	13	11	13	15	11	9.1
Cl mg/l	133	30	42	53	31	25	31	48	4.7	2.6
CO_3 mg/l										
HCO_3 mg/l	37	21	24	13	21	20	27	39	21	14
K mg/l	13	5.3	4.6	4.0	3.7	3.1	3.3	3.6	4.2	2.8
Mg mg/l	38	5.8	4.2	3.9	3.5	3.0	4.0	4.2	8.0	5.9
Na mg/l	150	28	36	48	30	24	29	44	8.0	5.6
SiO_2 mg/l	2.3	1.5	2.0	2.5	2.2	2.0	2.4	2.9	0.8	0.5
SO_4 mg/l	54	23	26	29	20	17	19	25	4.0	2.4
METALS										
Cd mg/l	0.02	0	0	0	0	0	0	0	0	0
Cr mg/l	0.26	0.05	0.03	0.02	0.02	0.02	0.02	0.02	0.08	0.01
Cu mg/l	0.32	0.06	0.05	0.05	0.05	0.04	0.04	0.04	0.07	0.04
Fe mg/l	76	17	9.4	8.1	7.7	7.2	8.0	7.9	29	19
Hg mg/l $\times 10^{-3}$	0.5	<0.2	—	—	—	—	—	—	—	<0.2
Mn mg/l	2.20	0.41	0.30	0.28	0.26	0.22	0.23	0.21	0.44	0.32
Mo mg/l	< 0.04	—	—	—	—	—	—	—	—	<0.04
Ni mg/l	0.38	0.08	0.07	0.08	0.08	0.05	0.05	0.06	0.10	0.08
Pb mg/l	8.0	1.5	0.9	0.8	0.8	0.7	0.7	0.7	2.3	1.6
Zn mg/l	22	0.88	1.20	1.00	0.72	0.76	1.24	2.80	0.60	0.40
Lab pH 25°C	6.6	6.6	6.6	5.6	6.4	6.5	6.7	7.0	7.3	6.8
NUTRIENTS										
Nitrate (N) mg/l	7.0	3.8	4.4	4.4	3.9	2.2	3.2	3.6	0.35	0.35
Kjeldahl (N) mg/l	20	5.6	5.6	6.2	4.9	4.7	4.6	4.9	5.4	1.9
Ammonia (N) mg/l	3.3	2.2	1.9	2.0	1.8	1.8	1.8	1.9	1.0	0.4
Total P mg/l	0.92	0.49	0.39	0.37	0.33	0.29	0.31	0.30	0.68	0.39
Ortho P mg/l	0.30	0.19	0.02	0.01	0.00	0.01	0.01	0.02	0.18	0.13
MISCELLANEOUS										
Oil & Grease mg/l	118	119	143	0	0	3	27	25	0	0
Total Solids mg/l	1290	406	414	441	336	300	326	398	748	428
Volatile Portion (T.S.)%	36	26	42	41	43	43	43	40	24	22
Total Sus. Solids mg/l	670	151	117	119	90	101	90	90	679	378
Volatile Portion (T.S.S.)%	35	<1	38	39	38	39	32	30	22	20
COD mg/l	662	325	298	310	257	219	241	274	267	139
PRECIPITATION (p)										
Δp, (inches)	0.03	0.00	0.01	0.01	0.01	0.01	0.01	0.00	0.13	0.03
p, (Total)	0.03	0.03	0.04	0.05	0.06	0.07	0.08	0.08	0.21	0.24

PROJECT LOCATION Placerville DIST. 03 CO. ED RTE 50 P.M. 15.5

PARAMETER	DATE 2/8/77	STORM NO. 2								
SAMPLE NO.	11	12								
TIME	1555	1630								
FIELD										
Flow, cfs	0.008	0.0007								
Temp, °C	9.2	9.5								
Cond, μmhos/cm	85	105								
pH	7.0	7.3								
DO mg/l	-	-								
MAJOR IONS										
B mg/l	0.05	0.08								
Ca mg/l	4.1	5.2								
Cl mg/l	4.2	7.0								
CO_3 mg/l										
HCO_3 mg/l	14	19								
K mg/l	1.2	1.3								
Mg mg/l	1.7	1.5								
Na mg/l	9.7	8.2								
SiO_2 mg/l	0.7	1.3								
SO_4 mg/l	3.7	5.8								
METALS										
Cd mg/l	0	0								
Cr mg/l	0.07	0.03								
Cu mg/l	0.02	0.07								
Fe mg/l	5.0	3.9								
Hg mg/l $\times 10^{-3}$	<0.2	<0.2								
Mn mg/l	0.10	0.10								
Mo mg/l	<0.04	<0.04								
Ni mg/l	0.03	0.04								
Pb mg/l	0.04	0.3								
Zn mg/l	0.24	0.44								
Lab pH 25°C	6.8	6.8								
NUTRIENTS										
Nitrate (N) mg/l	0.35	0.35								
Kjeldahl (N) mg/l	1.2	1.5								
Ammonia (N) mg/l	0.5	0.7								
Total P mg/l	0.14	0.12								
Ortho P mg/l	0.05	0.04								
MISCELLANEOUS										
Oil & Grease mg/l	18	13								
Total Solids mg/l	120	118								
Volatile Portion (TS) %	42	46								
Total Sus Solids mg/l	62	33								
Volatile Portion (TSS) %	35	36								
COD mg/l	59	72								
PRECIPITATION (p)										
Δp, (inches)	0.02	0.02								
p, (Total)	0.26	0.28								

PROJECT · LOCATION Placerville DIST. 03 CO ED RTE 50 P.M. 15.5

PARAMETER	DATE 3/16/77				STORM NO. 3					
SAMPLE NO.	1	2	3	4	5	6	7	8	9	10
TIME	0915	0930	0945	1000	1015	1030	1100	1130	1230	1330
FIELD										
Flow, cfs (timed)	0.084	0.13	0.067	0.042	0.023	0.011	0.004	0.061	0.074	0.035
Temp, °C	6.8	7.1	7.1	7.2	7.2	7.1	6.3	7.1	7.5	8.6
Cond, μmhos/cm 25°C	432	149	155	170	192	218	313	210	111	147
pH	9.2	9.0	11.5	10.2	9.1	9.0	9.0	8.9	8.8	8.8
DO mg/l	7.0	6.7	6.8	6.8	6.8	6.6	7.1	6.7	6.6	6.7
MAJOR IONS										
B mg/l	0.12	0.09	0.09	0.09	0.10	0.11	0.09	0.09	0.08	0.11
Ca mg/l	13	9.8	6.6	5.9	5.9	6.5	9.5	8.4	5.2	6.0
Cl mg/l	73	27	25	28	32	38	56	44	17	20
CO_3 mg/l										
HCO_3 mg/l	31	25	22	24	27	28	37	33	19	26
K mg/l	2.6	4.2	2.9	2.2	2.0	1.7	2.2	2.4	1.8	1.7
Mg mg/l	5.3	10	6.1	4.5	4.0	3.5	4.1	5.8	3.8	3.0
Na mg/l	88	28	25	26	30	34	48	42	19	25
SiO_2 mg/l	3.3	1.6	1.6	1.7	2.3	2.8	4.3	3.6	1.7	2.5
SO_4 mg/l	11	6.0	6.0	6.0	7.0	7.7	9.8	11	4.0	3.5
METALS										
Cd mg/l	0	0	0	0	0	0	0	0	0	0
Cr mg/l	0.04	0.10	0.06	0.05	0.04	0.03	0.03	0.05	0.04	0.02
Cu mg/l	0.06	0.08	0.06	0.05	0.04	0.04	0.03	0.05	0.04	0.03
Fe mg/l	13	31	19	14	13	10	10	19	13	8.9
Hg mg/l $\times 10^{-3}$	<0.2									<0.2
Mn mg/l	0.23	0.48	0.30	0.22	0.20	0.17	0.18	0.30	0.19	0.14
Mo mg/l	<0.04									<0.04
Ni mg/l	0.10	0.16	0.12	0.11	0.08	0.09	0.10	0.12	0.10	0.10
Pb mg/l	0.6	1.3	0.8	0.6	0.5	0.5	0.5	0.8	0.5	0.4
Zn mg/l	0.68	0.44	0.36	0.32	0.36	0.40	0.68	0.40	0.24	0.28
Lab pH 25°C	7.5	7.5	7.2	7.3	7.3	7.3	7.4	7.4	7.2	7.2
NUTRIENTS										
Nitrate (N) mg/l	0.9	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.7
Kjeldahl (N) mg/l	2.3	2.7	1.6	1.4	1.3	1.6	1.5	1.9	1.4	1.1
Ammonia (N) mg/l	0.5	0.6	0.5	0.4	0.4	0.5	0.4	0.5	0.5	0.3
Total P mg/l	0.36	0.52	0.33	0.26	0.23	0.21	0.25	0.29	0.22	0.17
Ortho P mg/l	0.06	0.11	0.07	0.06	0.05	0.04	0.03	0.05	0.07	0.05
MISCELLANEOUS										
Oil & Grease mg/l	0	0	0	0	72	1	54	31	28	0
Total Solids mg/l	516	689	386	321	288	274	315	393	255	213
Volatile Portion (TS)%	25	33	24	29	28	29	26	26	24	27
Total Sus Solids mg/l	296	586	294	218	164	136	120	245	177	91
Volatile Portion (TSS)%	23	33	20	28	24	32	27	27	23	24
COD mg/l	188	222	152	116	108	106	114	157	98	85
PRECIPITATION (p)										
Δp, (inches)	0.07	0.01	0.01	0.01	0.01	0.00	0.01	0.03	0.03	0.03
p, (Total)	0.07	0.08	0.09	0.10	0.11	0.11	0.12	0.15	0.18	0.21

PROJECT ______ LOCATION Placerville DIST. 03 CO. ED RTE. 50 P.M. 15.5

PARAMETER	DATE 3/16/77 STORM NO. 3
SAMPLE NO.	11
TIME	1430
FIELD	
Flow, cfs (timed)	0.02
Temp, °C	9.9
Cond, µmhos/cm	160
pH	8.7
D.O. mg/l	6.9
MAJOR IONS	
B mg/l	0.10
Ca mg/l	7.1
Cl mg/l	25
CO_3 mg/l	
HCO_3 mg/l	28
K mg/l	1.9
Mg mg/l	3.6
Na mg/l	27
SiO_2 mg/l	3.1
SO_4 mg/l	5.7
METALS	
Cd mg/l	0
Cr mg/l	0.03
Cu mg/l	0.03
Fe mg/l	10
Hg mg/l $\times 10^{-3}$	<0.02
Mn mg/l	0.17
Mo mg/l	<0.04
Ni mg/l	0.08
Pb mg/l	0.5
Zn mg/l	0.36
Lab pH 25°C	7.3
NUTRIENTS	
Nitrate (N) mg/l	0.9
Kjeldahl (N) mg/l	1.5
Ammonia (N) mg/l	0.5
Total P mg/l	0.18
Ortho P mg/l	0.05
MISCELLANEOUS	
Oil & Grease mg/l	0
Total Solids mg/l	243
Volatile Portion (T.S.)%	28
Total Sus. Solids mg/l	92
Volatile Portion (T.S.S)%	29
COD mg/l	106
PRECIPITATION (p)	
Δp, (inches)	0.00
p, (Total)	0.21

WALNUT CREEK 1976-77

PROJECT —— LOCATION Walnut Creek DIST. 04 CO. CC RTE 680 P.M. ____

PARAMETER	DATE October 1, 1976	STORM NO. 1								
SAMPLE NO.	1	2	3	4	5					
TIME	1230	1245	1300	1315	1400					
FIELD										
Flow, cfs	0.003	0.003	0.003	0.003	0.001					
Temp, °C	18.6	18.1	18.7	18.6	18.9					
Cond, µmhos/cm	211	177	193	210	253					
pH	7.4	7.2	7.1	7.2	7.3					
D.O. mg/l	5.7	5.3	5.2	5.2	5.0					
MAJOR IONS										
B mg/l	0.17	0.17	0.16	0.22	0.21					
Ca mg/l	29	32	33	34	37					
Cl mg/l	13	10	11	13	18					
CO_3 mg/l	0	0	0	0	0					
HCO_3 mg/l	63	61	61	62	61					
K mg/l	4.8	5.1	5.2	5.4	5.2					
Mg mg/l	8.0	7.0	6.6	6.4	6.2					
Na mg/l	6.2	7.6	8.2	9.1	9.8					
SiO_2 mg/l	7.9	11.9	11.0	13.0	13.0					
SO_4 mg/l	23	22	23	27	34					
METALS										
Cd mg/l	0.00	0.01	0.01	0.00	0.00					
Cr mg/l	0.07	0.06	0.06	0.05	0.04					
Cu mg/l	0.13	0.12	0.12	0.13	0.13					
Fe mg/l	24	21	18	17	14					
Hg mg/l x 10^{-3}	0.2	0.3	< 0.2	< 0.2	< 0.2					
Mn mg/l	0.42	0.38	0.35	0.34	0.31					
Mo mg/l	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04					
Ni mg/l	0.10	0.10	0.08	0.08	0.08					
Pb mg/l	3.0	2.7	2.8	2.8	2.3					
Zn mg/l	0.72	0.64	0.72	0.72	0.72					
Lab pH @ 25°C	7.5	7.4	7.5	7.3	7.1					
NUTRIENTS										
Nitrate (N) mg/l	1.7	1.7	1.8	2.0	2.4					
Kjeldahl (N) mg/l	5.6	14.0	4.8	4.0	5.0					
Ammonia (N) mg/l	1.3	1.6	1.7	2.0	2.2					
Total P mg/l	0.79	0.57	0.53	0.53	0.46					
Ortho P mg/l	0.26	0.12	0.13	0.11	0.08					
MISCELLANEOUS										
Oil & Grease mg/l	16	24	31	32	20					
Total Solids mg/l	829	511	499	499	482					
Volatile Portion (TS) %	24	31	38	43	48					
Total Sus. Solids mg/l	627	330	305	275	230					
Volatile Portion (TSS) %	16	18	22	27	32					
COD mg/l	241	247	245	250	261					
PRECIPITATION (p)										
Δp (inches)	0.03	0.10	0.08	0.05	0.15					
p (total)	0.03	0.13	0.21	0.26	0.41					

PROJECT LOCATION Walnut Creek DIST. 04 CO. CC RTE 680 P.M. 15.9

PARAMETER	DATE November 11, 1976 STORM NO. 2									
SAMPLE NO.	1	2	3	4	5	6	7	8	9	10
TIME	0935	0950	1005	1020	1035	1050	1120	1150	1220	1305
FIELD										
Flow, cfs	0.93	0.76	0.76	0.65	0.76	0.60	0.10	0.81	1.45	0.03
Temp, °C	14.6	14.5	14.6	14.5	14.6	14.9	15.1	14.7	14.1	14.6
Cond, µmhos/cm	239	210	211	203	192	202	228	203	138	191
pH	7.0	6.9	7.1	7.1	7.1	7.1	7.1	7.3	7.4	7.3
D.O. mg/l	6.7	5.9	5.8	5.8	5.7	5.6	5.5	5.6	5.1	5.5
MAJOR IONS										
B mg/l	0.34	0.20	0.23	0.23	0.21	0.21	0.22	0.22	0.15	0.26
Ca mg/l	26	30	31	32	31	31	33	32	25	31
Cl mg/l	16	14	13	12	12	12	15	12	7	11
CO_3 mg/l	0	0	0	0	0	0	0	0	0	0
HCO_3 mg/l	26	41	49	38	43	45	44	46	41	48
K mg/l	4.6	5.3	5.0	5.0	5.1	4.9	4.9	5.3	4.2	4.6
Mg mg/l	5.8	6.9	6.6	6.4	6.6	6.1	6.1	6.7	5.8	5.3
Na mg/l	7.0	7.4	7.4	7.4	7.4	7.3	8.5	7.4	5.7	7.6
SiO_2 mg/l	4.2	4.8	5.4	5.6	5.4	6.1	7.1	6.8	5.4	7.5
SO_4 mg/l	28	28	26	26	24	25	28	26	16	23
METALS										
Cd mg/l	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.01
Cr mg/l	0.03	0.05	0.05	0.04	0.04	0.04	0.03	0.04	0.05	0.03
Cu mg/l	0.17	0.20	0.20	0.20	0.20	0.19	0.24	0.25	0.18	0.17
Fe mg/l	13	17	17	17	18	16	15	19	19	14
Hg mg/l $\times 10^{-3}$	0.2	0.2	0.2	0.2	0.5	0.6	0.7	0.7	0.5	0.5
Mn mg/l	0.34	0.40	0.37	0.35	0.37	0.33	0.34	0.36	0.32	0.29
Mo mg/l	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Ni mg/l	0.08	0.08	0.08	0.09	0.09	0.08	0.12	0.10	0.09	0.08
Pb mg/l	2.2	2.5	2.5	2.5	2.7	2.5	2.8	3.1	2.6	2.3
Zn mg/l	0.80	0.80	0.80	0.80	0.80	0.72	0.88	0.80	0.64	0.72
Lab pH @ 25°C	7.0	7.1	7.2	7.2	7.2	7.2	7.2	7.3	7.5	7.3
NUTRIENTS										
Nitrate (N) mg/l	3.5	3.1	2.9	2.8	2.6	1.8	3.0	3.1	1.6	2.4
Kjeldahl (N) mg/l	3.0	6.5	6.1	5.8	5.4	5.1	5.6	5.2	3.4	3.8
Ammonia (N) mg/l	3.1	2.9	2.6	2.5	2.4	2.5	2.6	2.2	1.5	2.0
Total P mg/l	0.45	0.53	0.53	0.51	0.54	0.48	0.49	0.55	0.50	0.42
Ortho P mg/l	0.09	0.13	0.12	0.09	0.09	0.07	0.09	0.13	0.11	0.07
MISCELLANEOUS										
Oil & Grease mg/l	52	0	0	15	23	20	55	23	45	38
Total Solids mg/l	460	553	531	521	520	466	487	524	462	424
Volatile Portion (T.S.) %	50	46	40	42	40	40	42	35	29	35
Total Sus. Solids mg/l	206	315	295	297	305	276	265	329	332	240
Volatile Portion (T.S.S.) %	28	31	23	28	26	31	35	27	23	27
COD mg/l	319	314	304	306	290	282	300	294	213	242
PRECIPITATION (p)										
Δp, (inches)	0.05	0.03	0.01	0.01	0.02	0.02	0.02	0.03	0.01	0.00
p, (total)	0.05	0.08	0.09	0.10	0.12	0.14	0.16	0.19	0.20	0.20

PROJECT LOCATION Walnut Creet DIST. 04 CO. CC RTE. 680 P.M. 15.9

PARAMETER	DATE December 29-30,1976 STORM NO. 3									
SAMPLE NO.	1	2	3	4	5	6	7	8	9	10
TIME	2110	2130	2145	2200	2215	2245	2315	0015	0115	015[illegible]
FIELD										
Flow, cfs	0.02	0.93	0.99	0.23	0.23	0.42	0.42	0.42	0.02	0.2[illegible]
Temp, °C	11.6	10.3	9.9	9.9	9.8	9.8	9.8	9.5	9.3	9.0
Cond, µmhos/cm	2105	675	182	146	140	113	105	78	150	151
pH	10.4	10.9	9.9	9.4	9.3	9.3	9.6	9.2	9.4	9.2
DO mg/l	6.3	6.7	7.0	7.0	7.0	7.0	7.0	7.2	7.2	7.4
MAJOR IONS										
B mg/l	0.55	0.32	0.25	0.22	0.21	0.22	0.18	0.17	0.17	0.1[illegible]
Ca mg/l	270	140	30	26	20	20	17	17	22	20
Cl mg/l	240	31	11	7.8	7.8	8.3	2.6	3.9	9.6	12
CO_3 mg/l	80	81	0	2	0	3	0	0	0	0
HCO_3 mg/l	87	0	34	38	31	39	35	23	40	34
K mg/l	16	14	3.6	3.3	2.9	2.3	2.2	1.9	1.8	1.8
Mg mg/l	22	17	4.8	4.2	3.2	2.5	2.4	1.6	1.9	1.9
Na mg/l	100	19	6.0	5.0	4.8	3.9	3.3	2.5	5.0	5.9
SiO_2 mg/l	34	22	4.8	5.2	4.2	5.7	4.8	3.1	6.1	5.4
SO_4 mg/l	440	47	25	19	19	14	11	7.4	15	15
METALS										
Cd mg/l	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0[illegible]
Cr mg/l	0.05	0.06	0.03	0.02	0.02	0.02	0.02	0.01	0.01	0.01
Cu mg/l	0.23	0.21	0.08	0.08	0.07	0.07	0.06	0.04	0.05	0.0[illegible]
Fe mg/l	15	34	10	10	7.7	6.9	6.4	3.8	3.3	3.6
Hg mg/l x10^{-3}	< 0.2	—	—	—	—	—	—	—	—	<0.2
Mn mg/l	0.96	0.87	0.21	0.20	0.16	0.14	0.12	0.08	0.08	0.0[illegible]
Mo mg/l	< 0.04	—	—	—	—	—	—	—	—	<0.04
Ni mg/l	0.14	0.15	0.06	0.07	0.06	0.05	0.04	0.04	0.05	0.07
Pb mg/l	3.2	5.4	1.7	1.5	1.3	1.1	1.0	0.7	0.7	0.7
Zn mg/l	1.64	1.60	0.40	0.40	0.32	0.32	0.24	0.16	0.16	0.2[illegible]
Lab pH @ 25°C	9.5	10.2	7.7	8.5	7.6	8.7	8.2	7.4	7.6	7.4
NUTRIENTS										
Nitrate (N) mg/l	18	1.4	1.2	0.85	0.85	0.60	0.45	0.35	0.85	0.8[illegible]
Kjeldahl (N) mg/l	36	12	5.0	3.6	3.1	2.2	2.0	1.3	2.0	1.8
Ammonia (N) mg/l	8.4	3.7	2.4	2.0	1.9	1.4	1.1	0.8	1.2	1.2
Total P mg/l	1.39	1.37	0.32	0.31	0.26	0.23	0.21	0.13	0.14	0.1[illegible]
Ortho P mg/l	0.81	0.74	0.12	0.12	0.09	0.09	0.08	0.06	0.05	0.0[illegible]
MISCELLANEOUS										
Oil & Grease mg/l	153	33	50	28	30	52	112	14	5	0
Total Solids mg/l	2340	1480	314	320	244	268	235	303	300	[illegible]
Volatile Portion (T.S.)%	35	28	34	36	35	27	26	78	74	60
Total Sus Solids mg/l	303	1067	189	216	128	168	173	244	175	125
Volatile Portion (T.S.S.)%	36	26	36	34	22	20	32	90	100	[illegible]
COD mg/l	806	368	189	160	145	112	100	63	114	114
PRECIPITATION (p)										
Δp, (inches)	0.01	0.00	0.01	0.00	0.00	0.01	0.01	0.01	0.01	0.0[illegible]
p, (total)	0.01	0.01	0.02	0.02	0.02	0.03	0.04	0.05	0.06	0.0[illegible]

PROJECT LOCATION Walnut Creek DIST. 04 CO. CC RTE. 680 P.M. 15.9

PARAMETER	DATE December 29-30,1976 STORM NO. 3								
SAMPLE NO.	11	12	13	14	15	16	17	18	19
TIME	0210	0225	0255	0355	1100	1130	1200	1300	1400
FIELD									
Flow, cfs	0.14	–	0.55	0.01	0.81	0.76	1.45	0.10	0.33
Temp, °C	8.9	9.0	8.6	8.2	–	–	–	–	–
Cond, μmhos/cm	142	159	70	118	–	–	–	–	–
pH	9.1	9.2	9.1	9.0	–	–	–	–	–
D.O. mg/l	7.4	7.3	7.5	7.6	–	–	–	–	–
MAJOR IONS									
B mg/l	0.16	0.18	0.17	0.16	0.26	0.24	0.23	0.21	0.22
Ca mg/l	18	23	11	17	34	26	19	15	12
Cl mg/l	11	14	4.9	7.0	22	11	5.2	5.2	3.4
CO_3 mg/l	0	0	0	0	0	0	0	0	0
HCO_3 mg/l	31	39	20	34	48	–	27	27	20
K mg/l	1.8	1.9	1.2	1.4	5.2	4.6	3.1	2.3	2.0
Mg mg/l	1.7	1.9	1.8	1.4	9.0	7.0	5.7	3.4	3.3
Na mg/l	5.8	6.9	3.1	4.6	12	8.0	4.7	4.1	3.1
SiO_2 mg/l	5.3	6.7	3.1	5.0	5.8	7.3	2.9	3.7	2.2
SO_4 mg/l	15	17	5.8	12	30	–	15	12	6.4
METALS									
Cd mg/l	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00
Cr mg/l	0.02	0.01	0.01	0.01	0.06	0.06	0.06	0.04	0.04
Cu mg/l	0.05	0.05	0.04	0.04	0.13	0.13	0.14	0.10	0.09
Fe mg/l	3.0	3.0	4.7	2.1	24	22	18	10	11
Hg mg/l $\times 10^{-3}$	<0.2								<0.2
Mn mg/l	0.08	0.09	0.08	0.06	0.47	0.37	0.32	0.18	0.18
Mo mg/l	<0.04								<0.04
Ni mg/l	0.06	0.05	0.05	0.05	0.10	0.11	0.10	0.07	0.08
Pb mg/l	0.6	0.6	0.8	0.4	2.7	2.3	2.2	1.5	1.6
Zn mg/l	0.16	0.20	0.16	0.12	0.64	0.56	0.48	0.32	0.36
Lab pH @ 25°C	7.3	7.6	7.5	7.5	7.9	–	7.8	7.8	7.7
NUTRIENTS									
Nitrate (N) mg/l	0.85	1.0	0.30	0.50	1.3	1.3	0.60	0.60	0.50
Kjeldahl (N) mg/l	1.7	1.8	0.9	1.0	3.5	2.4	1.6	1.4	1.1
Ammonia (N) mg/l	1.1	0.9	0.6	0.8	2.2	1.8	1.1	1.2	1.1
Total P mg/l	0.15	0.15	0.18	0.12	0.58	0.51	0.43	0.27	0.29
Ortho P mg/l	0.05	0.04	0.07	0.03	0.10	0.22	0.11	0.07	0.08
MISCELLANEOUS									
Oil & Grease mg/l	0	4	40	47	12	8	11	61	0
Total Solids mg/l	203	210	148	124	579	679	406	234	462
Volatile Portion (T.S.)%	49	46	34	43	29	34	26	31	61
Total Sus. Solids mg/l	95	83	94	36	388	232	339	180	235
Volatile Portion (TSS)%	103	117	65	12	248	176	132	135	121
COD mg/l									
PRECIPITATION (p)									
Δp, (inches)	0.01	0.01	0.01	0.02	0.07	0.00	0.01	0.01	0.01
p, (Total)	0.08	0.09	0.10	0.12	0.19	0.19	0.20	0.21	0.22

WALNUT CREEK 1977-78

PROJECT LOCATION Walnut Creek DIST. 04 CO. cc RTE 680 P.M. 12.7

PARAMETER	DATE November 21, 1977 STORM NO. 2									
SAMPLE NO.	2W-1	-2	-3	-4	-5	-6	-7	-8	-9	-10
TIME	0150	0205	0220	0235	0250	0305	0335	0435	0530	0700
FIELD										
Flow, cfs	.80	.80	.80	.60	.60	.80	.60	1.42	.60	.07
Temp, °C	8.9	8.7	8.7	8.5	8.2	8.2	8.2	8.0	9.4	9.2
Cond, μmhos/cm@ 25°C	71	63	67	73	58	59	64	55	58	1 25
pH	7.5	7.1	7.1	7.0	7.4	7.6	7.6	7.8	7.3	7.7
DO mg/l	12.1	12.1	11.9	11.9	12.0	12.0	11.9	11.8	11.8	11.1
MAJOR IONS										
B mg/l	0.07	0.11	0.13	0.08	0.16	0.13	0.11	0.14	0.10	0.13
Ca mg/l	9.3	9.4	10	12	11	10	10	10	10	22
Cl mg/l	1.7	2.5	2.4	2.9	1.8	2.1	2.3	2.0	2.1	6.6
CO_3 mg/l	0	0	0	0	0	0	0	0	0	0
HCO_3 mg/l	22	21	23	26	23	32	23	23	24	44
K mg/l	1.7	1.6	1.6	1.7	1.8	1.6	1.7	1.6	1.7	3.5
Mg mg/l	1.6	1.6	1.5	1.9	2.1	1.8	1.6	1.9	2.0	4.6
Na mg/l	3.1	3.3	3.0	3.3	2.6	2.5	2.8	2.3	2.2	5.2
SiO_2 mg/l	2.8	2.8	3.0	3.6	3.0	3.2	3.6	3.8	3.1	6.0
SO_4 mg/l	8.2	7.3	7.9	8.2	6.3	6.6	6.6	5.6	5.6	17
METALS										
Cd mg/l x 10^{-3}	<4	→	→	→	→	→	→	→	→	<4
Cr mg/l	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.03
Cu mg/l	0.07	0.06	0.06	0.07	0.08	0.07	0.07	0.08	0.08	0.12
Fe mg/l	4.3	4.4	4.1	5.6	7.0	5.3	4.5	6.0	6.4	12
Hg mg/l x 10^{-3}	<0.02	→	→	→	→	→	→	→	→	→
Mn mg/l	0.09	0.09	0.08	0.11	0.12	0.10	0.09	0.11	0.12	0.24
Mo mg/l	<0.04	→	→	→	→	→	→	→	→	→
Ni mg/l	0.04	0.04	0.04	0.04	0.04	0.06	0.04	0.05	0.04	0.06
Pb mg/l	0.5	0.5	0.5	0.6	0.7	0.6	0.6	0.6	0.8	1.8
Zn mg/l	0.18	0.17	0.16	0.18	0.21	0.19	0.17	0.20	0.21	0.45
Lab pH	7.2	7.2	7.2	7.2	7.4	7.3	7.8	7.4	7.3	7.1
NUTRIENTS										
Nitrate (N) mg/l	0.9	-	2.6	1.0	1.6	1.0	1.0	1.0	1.0	2.0
Kjeldahl (N) mg/l	1.5	0.8	1.6	1.5	1.5	1.4	1.3	1.3	1.4	2.8
Ammonia (N) mg/l	0.6	0.6	0.6	0.6	0.5	0.4	0.5	0.4	0.4	0.9
Total P mg/l	0.21	0.19	0.19	0.22	0.22	0.20	0.17	0.20	0.21	0.40
Ortho P mg/l	0.09	0.08	0.08	0.09	0.10	0.10	0.08	0.09	0.07	0.11
MISCELLANEOUS										
Oil n Grease mg/l	12	10	10	11	11	9	11	12	18	21
Total Solids mg/l	142	123	87	149	155	137	111	145	149	312
Volatile Portion (TS)%	33	39	100	35	36	38	36	29	39	33
Total Sus Solids mg/l	104	97	65	55	75	77	63	85	86	188
Volatile Portion (TSS)%	35	39	100	2	31	28	40	15	27	25
COD mg/l	62	62	59	71	68	53	55	73	89	170
PRECIPITATION (p)										
Δp, (inches)	.37	.03	.03	.04	.03	.04	.11	.10	.03	.23
p, (Total)	.37	.40	.43	.47	.50	.54	.65	.75	.78	1.01

LOS ANGELES 1977-78

LOS ANGELES 1976-77

PROJECT LOCATION L. A. DIST. 07 CO. RTE. 405 PM

PARAMETER	DATE 12/30/76	STORM NO. 1								
SAMPLE NO.	1	2	3	4	5	6	7	8	9	10
TIME	0745	0800	0815	0830	0845	0900	0915	0945	1015	1045
FIELD										
Flow, cfs	0.033	0.096	0.096	0.082	0.262	0.680	0.742	0.480	0.163	0.092
Temp, °C	13.2	13.2	13.3	13.4	13.1	12.9	12.9	13.2	13.9	14.2
Cond, μmhos/cm	889	740	634	497	276	169	133	80	69	96
pH	6.8	6.7	6.6	6.6	6.8	6.9	7.0	7.1	7.1	7.1
DO mg/l	9.2	8.9	9.6	10.0	9.3	9.4	9.4	10.3	9.6	8.9
MAJOR IONS										
B mg/l	4.6	3.2	2.6	2.3	1.1	0.64	0.42	0.31	0.17	0.19
Ca mg/l	94	79	67	62	27	18	13	10	7.9	9.9
Cl mg/l	142	122	102	81	35	21	16	11	8	12
CO_3 mg/l										
HCO_3 mg/l	18	14	14	13	9	10	9	9	7	9
K mg/l	13	11	10	9.2	4.9	4.1	3.2	2.5	1.7	1.7
Mg mg/l	8.6	7.6	6.6	6.2	3.7	4.0	3.1	2.1	1.3	1.5
Na mg/l	43	37	33	30	14	10	8.3	6.6	4.8	6.3
SiO_2 mg/l	3.4	3.2	3.1	3.2	1.9	1.3	1.2	1.1	1.0	1.4
SO_4 mg/l	146	111	98	83	41	25	19	15	11	13
METALS										
Cd mg/l	0.06	0.04	0.03	0.02	0.01	0.01	0.01	0.01	0	0
Cr mg/l	0.02	0.02	0.02	0.02	0.02	0.03	0.02	0.02	0.02	0.01
Cu mg/l	0.21	0.18	0.17	0.16	0.12	0.13	0.12	0.08	0.06	0.06
Fe mg/l	3.2	2.9	3.1	3.0	7.0	8.4	7.2	5.2	2.6	2.6
Hg mg/l X10^{-3}	5.5	0.4	1.5	0.4	0.2	<0.2	—	—	—	<0.2
Mn mg/l	0.56	0.45	0.38	0.35	0.23	0.20	0.16	0.11	0.07	0.08
Mo mg/l	< 0.04	—	—	—	—	—	—	—	—	<0.04
Ni mg/l	0.50	0.50	0.40	0.40	0.30	0.24	0.16	0.12	0.08	0.12
Pb mg/l	9.8	8.9	7.6	7.0	5.2	5.6	3.9	2.6	1.8	2.0
Zn mg/l	6.3	5.2	4.0	3.6	2.6	2.2	1.5	1.2	1.6	[illegible]
Lab pH @ 25°C	5.8	5.7	5.8	5.8	6.0	6.2	6.4	6.4	6.5	6.5
NUTRIENTS										
Nitrate (N) mg/l	0.55	0.35	0.35	0.35	0.65	1.7	2.6	1.9	1.2	1.9
Kjeldahl (N) mg/l	27	27	20	16	10	7.5	6.7	4.3	2.7	3.1
Ammonia (N) mg/l	17	16	14	12	7.0	4.2	3.1	2.4	1.7	2.0
Total P mg/l	0.59	0.45	0.40	0.42	0.42	0.50	0.39	0.27	0.17	0.16
Ortho P mg/l	0.15	0.10	0.08	0.07	0.09	0.11	0.09	0.06	0.04	0.03
MISCELLANEOUS										
Oil & Grease mg/l	32	26	71	36	0	54	22	0	26	69
Total Solids mg/l	989	806	707	585	444	431	570	367	[illegible]	[illegible]
Volatile Portion (TS)%	55	50	50	49	58	56	69	68	63	[illegible]
Total Sus Solids mg/l	119	91	100	71	186	290	463	264	[illegible]	[illegible]
Volatile Portion (TSS)%	100	69	74	72	70	62	74	73	70	[illegible]
COD mg/l	562	538	481	493	356	369	354	204	123	[illegible]
PRECIPITATION (p)										
Δp, (inches)	0.02	0.03	0.06	0.03	0.09	0.04	0.13	0.11	0.06	0.01
p, (Total)	0.02	0.05	0.11	0.14	0.23	0.27	0.40	0.51	0.57	

PROJECT LOCATION L. A. DIST. 07 CO. ___ RTE 405 P.M. ___

PARAMETER	DATE 12/30/76	STORM NO. 1								
SAMPLE NO.	11	12								
TIME	1115	1215								
FIELD										
Flow, cfs	0.043	0.023								
Temp, °C	14.6	14.9								
Cond, µmhos/cm	121	17								
pH	7.0	7.2								
DO mg/l	8.7	9.7								
MAJOR IONS										
B mg/l	0.25	0.33								
Ca mg/l	14	14								
Cl mg/l	16	17								
CO_3 mg/l										
HCO_3 mg/l	9	9								
K mg/l	2.1	2.5								
Mg mg/l	1.7	1.7								
Na mg/l	7.3	8.1								
SiO_2 mg/l	2.0	2.4								
SO_4 mg/l	18	20								
METALS										
Cd mg/l	0	0								
Cr mg/l	0.01	0.01								
Cu mg/l	0.06	0.06								
Fe mg/l	2.2	1.9								
Hg mg/l $\times 10^{-3}$	< 0.2	< 0.2								
Mn mg/l	0.08	1.00								
Mo mg/l	< 0.04	< 0.04								
Ni mg/l	0.14	0.14								
Pb mg/l	2.0	1.9								
Zn mg/l	1.0	1.0								
Lab pH @25°C	6.4	6.4								
NUTRIENTS										
Nitrate (N) mg/l	2.3	2.6								
Kjeldahl (N) mg/l	3.2	3.7								
Ammonia (N) mg/l	2.3	2.4								
Total P mg/l	0.16	0.16								
Ortho P mg/l	0.02	0.02								
MISCELLANEOUS										
Oil & Grease mg/l	28	19								
Total Solids mg/l	219	210								
Volatile Portion (TS) %	64	57								
Total Sus Solids mg/l	94	79								
Volatile Portion (TSS) %	78	76								
COD mg/l	141	142								
PRECIPITATION (p)										
Δp, (inches)										
p, (Total)										

PROJECT LOCATION L.A. DIST. 07 CO. RTE 405 P.M.

PARAMETER	DATE 1/5/77	STORM NO. 2								
SAMPLE NO.	1	2	3	4	5	6	7	8		
TIME	1610	1625	1640	1655	1710	1725	1755	1825		
FIELD										
Flow, cfs	0.068	0.096	0.082	0.182	0.402	0.129	0.015	0.068		
Temp, °C	13.7	13.7	13.4	13.2	12.7	12.8	12.9	12.4		
Cond, μmhos/cm	345	205	146	102	85	96	94	67		
pH	7.0	7.1	7.0	7.0	7.1	7.2	7.1	7.1		
DO mg/l	9.1	9.1	9.2	9.2	9.4	9.4	9.2	9.4		
MAJOR IONS										
B mg/l	0.18	0.16	0.19	0.12	0.11	0.14	0.16	0.14		
Ca mg/l	21	19	18	14	13	11	12	10		
Cl mg/l	29	27	24	18	11	10	11	7.8		
CO_3 mg/l										
HCO_3 mg/l	21	13	13	12	15	26	10	6		
K mg/l	3.7	3.3	3.2	2.7	3.4	2.4	2.3	1.9		
Mg mg/l	3.0	2.9	2.9	2.5	3.8	2.4	2.4	1.8		
Na mg/l	18	11	11	8.5	6.5	6.1	6.7	5.1		
SiO_2 mg/l	1.6	1.5	1.7	1.9	1.4	1.7	2.0	2.0		
SO_4 mg/l	42	32	29	21	17	17	19	15		
METALS										
Cd mg/l	0.01	0.01	0	0	0.01	0	0.01	0		
Cr mg/l	0.03	0.04	0.01	0.02	0.04	0.02	0.02	0.02		
Cu mg/l	0.08	0.06	0.06	0.06	0.10	0.06	0.06	0.04		
Fe mg/l	4.5	4.2	4.6	5.1	11	6.2	4.9	4.0		
Hg mg/l $\times 10^{-3}$	<0.2	<0.2	0.2	0.2	0.2	<0.2	<0.2	<0.2		
Mn mg/l	0.16	0.16	0.16	0.13	0.21	0.12	0.11	0.08		
Mo mg/l	<0.04							<0.04		
Ni mg/l	0.10	0.14	0.16	0.14	0.16	0.11	0.11	0.10		
Pb mg/l	1.7	1.8	1.6	1.7	3.6	1.4	1.2	1.2		
Zn mg/l	0.8	1.0	0.9	0.7	1.1	0.9	0.7	0.6		
Lab pH @25°C	7.0	6.8	6.8	6.9	7.1	7.2	7.2	7.1		
NUTRIENTS										
Nitrate (N) mg/l	2.2	2.8	2.4	1.6	1.1	1.2	1.3	1.0		
Kjeldahl (N) mg/l	7.7	6.2	5.9	5.4	4.3	3.7	3.7	3.3		
Ammonia (N) mg/l	3.5	3.7	3.9	3.0	2.2	2.3	2.4	2.1		
Total P mg/l	0.27	0.23	0.26	0.26	0.34	0.26	0.23	0.19		
Ortho P mg/l	0.09	0.10	0.09	0.10	0.15	0.12	0.10	0.08		
MISCELLANEOUS										
Oil & Grease mg/l	128	0	88	126	31	73	0	59		
Total Solids mg/l	387	292	270	227	319	229	346	319		
Volatile Portion (T.S.)%	54	52	56	58	54	47	75	76		
Total Sus Solids mg/l	150	82	61	86	57	10	229	192		
Volatile Portion (T.S.S.)%	59	41	61	63	67	<1	86	78		
COD mg/l	363	194	194	196	195	171	165	130		
PRECIPITATION (p)										
Δp, (inches)	0.04	0.01	0.02	0.03	<0.01	<0.01	0.01	0.02		
p, (Total)	0.04	0.05	0.07	0.10	0.10+	0.10+	0.11	0.13		

PROJECT LOCATION L.A. DIST. 07 CO. ____ RTE 405 P.M. ____

PARAMETER	DATE 1/5/77				STORM NO. 2					
SAMPLE NO.	1	2	3	4	5	6	7	8		
TIME	1610	1625	1640	1655	1710	1725	1755	1825		
FIELD										
Flow, cfs	0.068	0.096	0.082	0.182	0.402	0.128	0.015	0.068		
Temp, °C	13.7	13.7	13.4	13.2	12.7	12.9	12.9	12.4		
Cond, µmhos/cm	345	205	146	102	85	96	94	67		
pH	7.0	7.1	7.0	7.0	7.1	7.2	7.1	7.1		
D.O. mg/l	9.1	9.1	9.2	9.2	9.4	9.4	9.2	9.4		
MAJOR IONS										
B mg/l	0.18	0.16	0.19	0.12	0.11	0.14	0.16	0.14		
Ca mg/l	21	19	18	14	13	11	12	10		
Cl mg/l	29	27	24	18	11	10	11	7.8		
CO_3 mg/l										
HCO_3 mg/l	21	13	13	12	15	26	10	6		
K mg/l	3.7	3.3	3.2	2.7	3.4	2.4	2.3	1.9		
Mg mg/l	3.0	2.9	2.9	2.5	3.8	2.4	2.4	1.8		
Na mg/l	18	11	11	8.5	6.5	6.1	6.7	5.1		
SiO_2 mg/l	1.6	1.5	1.7	1.9	1.4	1.7	2.0	2.0		
SO_4 mg/l	42	32	29	21	17	17	19	15		
METALS										
Cd mg/l	0.01	0.01	0	0	0.01	0	0.01	0		
Cr mg/l	0.03	0.04	0.01	0.02	0.04	0.02	0.02	0.02		
Cu mg/l	0.08	0.06	0.06	0.06	0.10	0.06	0.06	0.04		
Fe mg/l	4.5	4.2	4.6	5.1	11	6.2	4.9	4.0		
Hg mg/l $\times 10^{-3}$	<0.2	<0.2	0.2	0.2	0.2	<0.2	<0.2	<0.2		
Mn mg/l	0.16	0.16	0.16	0.13	0.21	0.12	0.11	0.08		
Mo mg/l	<0.04							<0.04		
Ni mg/l	0.10	0.14	0.16	0.14	0.16	0.11	0.11	0.10		
Pb mg/l	1.7	1.8	1.6	1.7	3.6	1.4	1.2	1.2		
Zn mg/l	0.8	1.0	0.9	0.7	1.1	0.9	0.7	0.6		
Lab pH @25°C	7.0	6.8	6.8	6.9	7.1	7.2	7.2	7.1		
NUTRIENTS										
Nitrate (N) mg/l	2.2	2.8	2.4	1.6	1.1	1.2	1.3	1.0		
Kjeldahl (N) mg/l	7.7	6.2	5.9	5.4	4.3	3.7	3.7	3.3		
Ammonia (N) mg/l	3.5	3.7	3.9	3.0	2.2	2.3	2.4	2.1		
Total P mg/l	0.27	0.23	0.26	0.26	0.34	0.26	0.23	0.19		
Ortho P mg/l	0.09	0.10	0.09	0.10	0.15	0.12	0.10	0.08		
MISCELLANEOUS										
Oil & Grease mg/l	128	0	88	126	31	73	0	59		
Total Solids mg/l	387	292	270	227	319	229	346	318		
Volatile Portion (T.S.) %	54	52	56	58	54	47	75	76		
Total Sus. Solids mg/l	150	82	61	86	57	10	229	182		
Volatile Portion (T.S.S.) %	59	41	61	63	67	<1	86	78		
COD mg/l	363	194	194	196	195	171	165	130		
PRECIPITATION (p)										
Δp, (inches)	0.04	0.01	0.02	0.03	<0.01	<0.01	0.01	0.02		
p, (Total)	0.04	0.05	0.07	0.10	0.10+	0.10+	0.11	0.13		

PROJECT LOCATION L. A. DIST. 07 CO. RTE 405 P.M.

PARAMETER	DATE 1/20/77	STORM NO. 3								
SAMPLE NO.	1	2	3	4	5	6	7	8		
TIME	2035	2050	2105	2120	2135	2150	2220	2250		
FIELD										
Flow, cfs	0.096	0.112	0.096	0.112	0.112	0.096	0.068	0.023		
Temp, °C	15.4	15.4	15.3	15.3	15.4	15.2	15.0	15.1		
Cond, μmhos/cm	712	307	466	161	63	191	169	182		
pH	6.3	6.3	6.3	6.4	6.4	6.5	6.5	6.6		
D.O. mg/l	8.7	8.9	8.7	9.2	8.8	9.0	8.8	8.7		
MAJOR IONS										
B mg/l	0.41	0.35	0.29	0.24	0.18	0.15	0.14	0.13		
Ca mg/l	64	56	45	32	24	19	17	18		
Cl mg/l	96	84	64	43	30	22	18	16		
CO_3 mg/l										
HCO_3 mg/l	15	13	12	12	11	10	11	13		
K mg/l	12	8	6.3	4.9	3.7	3.0	2.6	2.8		
Mg mg/l	6.8	5.4	4.4	3.1	2.2	1.8	1.6	1.8		
Na mg/l	44	27	20	14	11	8.7	7.9	8.2		
SiO_2 mg/l	2.2	2.2	2.2	2.0	2.2	2.0	2.1	2.4		
SO_4 mg/l	94	80	64	64	36	29	27	27		
METALS										
Cd mg/l	0.04	0.04	0.03	0.02	0.02	0.01	0.01	0.01		
Cr mg/l	0.01	0.01	0.01	0.01	0.01	0.01	0	0.02		
Cu mg/l	0.13	0.14	0.11	0.09	0.08	0.06	0.06	0.06		
Fe mg/l	2.2	2.4	2.0	1.9	1.6	1.5	1.2	1.2		
Hg mg/l $\times 10^{-3}$	< 0.2	< 0.2	0.2	< 0.2				< 0.2		
Mn mg/l	0.50	0.42	0.32	0.23	0.17	0.12	0.11	0.10		
Mo mg/l	< 0.04							< 0.04		
Ni mg/l	0.36	0.36	0.29	0.23	0.18	0.15	0.14	0.12		
Pb mg/l	3.3	4.7	4.0	3.2	2.5	2.1	1.7	1.7		
Zn mg/l	3.1	3.0	2.4	1.8	1.5	1.5	1.8	1.4		
Lab pH	6.0	5.9	6.0	6.1	6.2	6.3	6.4	6.6		
NUTRIENTS										
Nitrate (N) mg/l	11	11	11	5.8	5.2	4.7	2.9	3.8		
Kjeldahl (N) mg/l	19	14	14	12	9.0	7.9	6.0	5.7		
Ammonia (N) mg/l	12	9.1	8.7	7.0	5.5	4.5	4.0	3.8		
Total P mg/l	0.40	0.33	0.27	0.24	0.20	0.18	0.16	0.15		
Ortho P mg/l	0.09	0.07	0.05	0.03	0.02	0.02	0.01	0.01		
MISCELLANEOUS										
Oil & Grease mg/l	32	14	31	52	39	27	40	28		
Total Solids mg/l	664	567	462	360	275	237	181	174		
Volatile Portion (T.S.)%	47	50	54	56	60	60	56	49		
Total Sus. Solids mg/l	81	66	53	60	47	68	29	20		
Volatile Portion (T.S.S.)%	85	91	77	95	100	82	72	40		
COD mg/l	454	379	341	301	255	220	189	188		
PRECIPITATION (p)										
Δp, (inches)	0.01	0.01	0.01	0.01	0.02	0.00	0.01	0.00		
p, (Total)	0.01	0.02	0.03	0.04	0.06	0.06	0.07	0.07		

LOS ANGELES 1977-78

PROJECT LOCATION Los Angeles DIST. 07 CO. LA RTE 405 P.M. 19.0

PARAMETER	DATE January 3, 1978	STORM NO. 2								
SAMPLE NO.	LA-143	-144	-145	-146	-147	-148	-149	-150	-151	
TIME	1503	1518	1533	1548	1603	1633	1703	1733	1803	
FIELD										
Flow, cfs	.033	.055	.068	.145	.163	.33	.082	.043	.015	
Temp, °C	15.5	15	14.6	14.1	14.3	13.5	13.6	13.8	14	
Cond, μmhos/cm										
pH	6.3	6.5	6.5	6.6	6.6	6.3	6.6	6.5	6.4	
DO mg/l	8.04	7.93	8.0	9.13	8.20	8.46	8.20	9.08	8.68	
MAJOR IONS										
B mg/l	1.32	1.16	1.01	0.20	0.20	0.61	0.28	0.20	0.21	
Ca mg/l	43	34	27	18	12	8.0	9.1	10	12	
Cl mg/l	38	26	26	11	5.5	3.0	3.6	4.0	5.2	
CO_3 mg/l	0	0	0	0	0	0	0	0	0	
HCO_3 mg/l	25	21	21	12	11	5	10	12	15	
K mg/l	6.8	5.6	4.7	3.1	2.2	1.9	2.0	2.0	1.9	
Mg mg/l	5.2	4.3	3.5	2.5	1.7	1.5	1.6	1.6	1.5	
Na mg/l	26	19	13	7.5	4.7	2.9	3.3	4.0	4.3	
SiO_2 mg/l	6.1	5.3	4.7	3.6	3.0	2.1	2.5	2.9	3.2	
SO_4 mg/l	78	61	46	30	19	11	12	14	15	
METALS										
Cd mg/l $\times 10^{-3}$	12	8	8	8	4	4	4	4	4	
Cr mg/l	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	
Cu mg/l	0.14	0.12	0.10	0.09	0.07	0.07	0.06	0.06	0.05	
Fe mg/l	7.4	6.7	6.8	5.5	4.3	4.7	4.5	4.2	3.1	
Hg mg/l $\times 10^{-3}$	<0.2									
Mn mg/l	0.30	0.27	0.23	0.18	0.11	0.10	0.10	0.10	0.09	
Mo mg/l	<0.04									
Ni mg/l	0.16	0.12	0.10	0.07	0.06	0.06	0.05	0.04	0.04	
Pb mg/l	1.7	1.7	1.6	1.6	1.2	1.4	1.0	1.0	1.0	
Zn mg/l	1.44	1.18	1.13	1.00	0.72	0.53	0.48	0.55	0.59	
Lab pH	6.4	6.7	6.4	6.2	6.5	5.8	6.3	6.4	6.7	
NUTRIENTS										
Nitrate (N) mg/l	8.8	6.4	4.5	2.9	2.0	1.6	1.6	1.8	1.9	
Kjeldahl (N) mg/l	11.3	10.4	7.2	5.1	5.0	2.5	2.5	2.8	2.6	
Ammonia (N) mg/l	6.1	5.6	4.0	3.2	3.0	1.4	1.4	1.8	1.5	
Total P mg/l	0.49	0.53	0.41	0.36	0.27	0.42	0.22	0.23	0.23	
Ortho P mg/l	0.21	0.16	0.13	0.13	0.10	0.24	0.04	0.03	0.04	
MISCELLANEOUS										
Oil & Grease mg/l	22	29	25	22	13	13	14	12	99	
Total Solids mg/l	467	391	339	271	178	170	166	160	162	
Volatile Portion (TS) %	34	40	38	39	43	39	38	39	53	
Total Sus Solids mg/l	188	172	173	140	89	110	99	89	67	
Volatile Portion (TSS) %	55	56	51	37	22	35	20	53	72	
COD mg/l	266	253	228	174	129	110	103	105	102	
PRECIPITATION (p)										
Δp, (inches)	.05	.01	.02	.02	.01	.08	–	–	.03	
p, (Total)	.05	.06	.08	.10	.11	.19	.19	.19	.22	

SLOPES 1 and 2 1977-78

PROJECT LOCATION ____ DIST. ____ CO. ____ RTE. ____ P.M. ____

PARAMETER	DATE January 1978				STORM NO.					
SAMPLE NO.	Jan 5	Jan 5	Jan14	Jan14						
TIME	Slope1	Slope2	Slope1	Slope2						
FIELD										
Flow, cfs										
Temp, °C	20	20	25	24						
Cond, µmhos/cm	12	56	9.7	180						
pH										
DO mg/l										
MAJOR IONS										
B mg/l										
Ca mg/l	1.8	450	2.2	320						
Cl mg/l	0.5	0.3	0.12	0.13						
CO_3 mg/l	0	0	0	0						
HCO_3 mg/l	1.8	32	55	102						
K mg/l	1.7	2.1	1.1	2.5						
Mg mg/l	9.4	10	21	14						
Na mg/l	19	1.7	22	33						
SiO_2 mg/l	4.8	3.1	4.9	8.0						
SO_4 mg/l	28	1.7	1.8	5.7						
METALS										
Cd mg/l										
Cr mg/l										
Cu mg/l $\times 10^{-3}$										
Fe mg/l	14	39	22	47						
Hg mg/l $\times 10^{-4}$										
Mn mg/l										
Mo mg/l										
Ni mg/l										
Pb mg/l	0.04	3.8	0.04	4.0						
Zn mg/l										
Lab pH	5.8	8.6	7.2	8.2						
NUTRIENTS										
Nitrate (N) mg/l	0.22	0.52	0.06	0.35						
Kjeldahl (N) mg/l	0.88	2.24	0.56	3.38						
Ammonia (N) mg/l	0.03	0.03	0.04	0.04						
Total P mg/l	0.24	0.97	0.20	0.82						
Ortho P mg/l	0.003	0.31	0.004	0.28						
MISCELLANEOUS										
Oil & Grease mg/l										
Total Solids mg/l										
Volatile Portion (T.S.)%										
Total Sus Solids mg/l	332	1620	275	1710						
Volatile Portion (T.S.S.)%										
COD mg/l	13	86	16	132						
PRECIPITATION (p)										
Δp, (inches)										
p, (total)										

APPENDIX B

Analysis of Variance (Factorial Design)
*95% Significance Level.

ANALYSIS OF VARIANCE (FACTORIAL DESIGN)

PLACERVILLE 1976-77

	F Ratio (Degrees of Freedom)			
	Between Treatments		Between Treatments and Control	
	F Ratio	(d.f.)	F Ratio	(d.f.)
STORM 2 SAMPLE 1 (unfiltered)				
Concentration	25.601	(3,9)*	10.842	(4,16)*
Time	3.301	(3,9)	4.553	(4,16)*
Time/Conc. Interaction	0.896	(9,32)	2.970	(16,50)*
STORM 2 SAMPLE 1 (filtered)				
Concentration	27.759	(3,9)*	11.448	(4,16)*
Time	5.785	(3,9)*	6.635	(4,16)*
Time/Conc. Interaction	0.877	(9,32)	3.707	(16,50)*
STORM 2 SAMPLE 2 (unfiltered)				
Concentration	4.161	(3,9)*	3.097	(4,16)*
Time	2.344	(3,9)	1.745	(4,16)
Time/Conc. Interaction	10.689	(9,32)*	13.469	(16,50)*
STORM 2 SAMPLE 2 (filtered)				
Concentration	0.177	(3,9)	0.240	(4,16)
Time	2.752	(3,9)	2.526	(4,16)
Time/Conc. Interaction	4.543	(9,32)*	4.798	(16,50)*
STORM 2 SAMPLE 6 (unfiltered)				
Concentration	5.593	(3,9)*	3.103	(4,16)*
Time	10.518	(3,9)*	5.592	(4,16)*
Time/Conc. Interaction	4.722	(9,32)*	8.758	(16,50)*

*significant

ANALYSIS OF VARIANCE (FACTORIAL DESIGN)

PLACERVILLE 1976-77 (Continued)

F Ratio (Degrees of Freedom)

	Between Treatments F Ratio	Between Treatments (d.f.)	Between Treatments and Control F Ratio	Between Treatments and Control (d.f.)
STORM 2 SAMPLE 10 (unfiltered)				
Concentration	7.303	(3,9)*	3.736	(4,16)*
Time	10.811	(3,9)*	5.147	(4,16)*
Time/Conc. Interaction	10.729	(9,32)*	20.669	(16,50)*
STORM 3 SAMPLE 1 (unfiltered)				
Concentration	0.375	(3,9)	0.554	(4,16)
Time	18.598	(3,9)*	8.932	(4,16)*
Time/Conc. Interaction	5.228	(9,32)*	10.661	(16,50)*
STORM 3 SAMPLE 5 (unfiltered)				
Concentration	3.222	(3,9)	2.527	(4,16)
Time	3.266	(3,9)	3.987	(4,16)*
Time/Conc. Interaction	5.160	(9,32)*	6.736	(16,50)*
STORM 3 SAMPLE 10 (unfiltered)				
Concentration	2.696	(3,9)	2.587	(4,16)
Time	1.485	(3,9)	1.603	(4,16)
Time/Conc. Interaction	4.913	(9,32)*	5.661	(16,50)*

*Significant

ANALYSIS OF VARIANCE (FACTORIAL DESIGN)

PLACERVILLE 1976-77

STORM 2 SAMPLE 2
Filtered vs. Unfiltered

F Ratio (Degrees of Freedom)

	Between Treatments		Between Treatments and Control	
	F Ratio	(d.f.)	F Ratio	(d.f.)
Concentration	29.159	(3,3)*	11.352	(4,15)*
Time	59.645	(3,3)*	7.138	(4,15)*
Conc/Time Interaction	0.937	(9,64)	5.612	(16,100)*
Samples	0.282	(1,1)	0.308	(1,1)
Conc/Sample Interaction	1.441	(3,64)	1.362	(4,100)
Time/Sample Interaction	0.018	(3,64)	0.028	(4,100)
Combined Interaction	0.835	(9,64)	0.820	(16,100)

STORM 2 SAMPLE 2
Filtered vs. Unfiltered

Concentration	0.605	(3,5)	0.582	(4,7)
Time	2.328	(3,5)	2.128	(4,8)
Conc/Time Interaction	8.564	(9.64)*	9.679	(16,100)*
Samples	0.374	(1,3)	0.405	(1,4)
Conc/Sample Interaction	13.378	(3,64)*	12.910	(4,100)*
Time/Sample Interaction	6.098	(3,64)*	6.086	(4,100)*
Combined Interaction	3.730	(9,64)*	4.443	(16,100)*

*Significant

ANALYSIS OF VARIANCE (FACTORIAL DESIGN)

PLACERVILLE 1976-77

STORM 2

	F Ratio (Degrees of Freedom)			
	Between Treatments		Between Treatments and Control	
	F Ratio	(d.f.)	F Ratio	(d.f.)
Concentration	6.479	(3,6)*	3.111	(4,22)*
Time	7.749	(3,8)*	2.801	(4,21)
Conc/Time Interaction	9.548	(9,128)*	18.908	(16,200)*
Samples	13.412	(3,8)*	5.358	(3,17)*
Conc/Sample Interaction	9.252	(9,128)*	16.506	(12,200)*
Time/Sample Interaction	3.082	(9,128)*	10.721	(12,200)*
Combined Interaction	2.991	(21,128)*	3.841	(48,200)*

STORM 3

	F Ratio	(d.f.)	F Ratio	(d.f.)
Concentration	1.421	(3,13)	1.544	(4,21)
Time	5.320	(3,11)*	4.221	(4,18)*
Conc/Time Interaction	16.473	(9,128)*	23.000	(16,200)*
Samples	1.954	(3,11)	1.752	(3,14)
Conc/Sample Interaction	7.359	(9,128)*	8.055	(12,200)*
Time/Sample Interaction	4.363	(9,128)	5.246	(12,200)*
Combined Interaction	2.263	(27,128)*	2.748	(48,200)*

*Significant

ANALYSIS OF VARIANCE (FACTORIAL DESIGN)

WALNUT CREEK 1976-77

F Ratio (Degrees of Freedom)

	Between Treatments F Ratio	Between Treatments (d.f.)	Between Treatments and Control F Ratio	Between Treatments and Control (d.f.)
STORM 1 SAMPLE 2				
Concentration	2.534	(3,9)	2.165	(4,16)
Time	2.893	(3,9)	2.443	(4,16)
Time/Conc. Interaction	1.674	(9,32)	2.030	(16,50)
STORM 1 SAMPLE 3				
Concentration	3.162	(3,9)	2.694	(4,16)
Time	1.159	(3,9)	1.045	(4,16)
Time/Conc. Interaction	6.079	(9,32)*	6.921	(16,50)*
STORM 1 SAMPLE 4				
Concentration	10.611	(3,9)*	6.994	(4,16)*
Time	1.781	(3,9)	2,254	(4,16)
Time/Conc. Interaction	3.939	(9,32)*	5.751	(16,50)*
STORM 2 SAMPLE 2				
Concentration	6.972	(3,9)*	4.952	(4,16)*
Time	0.564	(3,9)	0.402	(4,16)
Time/Conc. Interaction	1.667	(3,32)	2.202	(16,50)*
STORM 2 SAMPLE 5				
Concentration	4.232	(3,9)*	3.241	(4,16)*
Time	2.648	(3,9)	2.096	(4,16)
Time/Conc. Interaction	4.421	(9,32)*	5.733	(16,50)*

*Significant

ANALYSIS OF VARIANCE (FACTORIAL DESIGN)

WALNUT CREEK 1976-77 (Continued)

F Ratio (Degrees of Freedom)

	Between Treatments F Ratio	Between Treatments (d.f.)	Between Treatments and Control F Ratio	Between Treatments and Control (d.f.)
STORM 3 SAMPLE 1				
Concentration	42.072	(3,12)*	9.196	(4,20)*
Time	30.234	(4,12)*	6.766	(5,20)*
Time/Conc. Interaction	9.635	(12,40)*	41.365	(20,60)*
STORM 3 SAMPLE 3				
Concentration	14.748	(3,12)*	5.276	(4,20)*
Time	22.573	(4,12)*	7.864	(5,20)*
Time/Conc. Interaction	3.929	(12,40)	11.256	(20,60)*
STORM 3 SAMPLE 8				
Concentration	1.081	(3,12)	0.735	(4,20)
Time	25.882	(4,12)*	10.042	(5,20)*
Time/Conc. Interaction	10.639	(12,40)*	26.876	(20,60)*
STORM 3 SAMPLE 15				
Concentration	2.523	(3,12)	2.136	(4,20)
Time	8.644	(4,12)*	5.741	(5,20)*
Time/Conc. Interaction	3.852	(12,40)*	5.974	(20,60)*

*Significant

ANALYSIS OF VARIANCE (FACTORIAL DESIGN)

WALNUT CREEK 1976-77

STORM 1

	F Ratio (Degrees of Freedom)			
	Between Treatments		Between Treatments and Control	
	F Ratio	(d.f.)	F Ratio	(d.f.)
Concentration	3.053	(3,13)	2.635	(4,20
Time	2.070	(3,5)	1.802	(4,16)
Conc/Time Interaction	8.754	(9,96)*	11.644	(16,150)*
Samples	3.554	(2,3)	2.715	(2,8)
Conc/Sample Interaction	6.844	(2,96)*	7.796	(8,150)*
Time/Sample Interaction	0.425	(9,96)	1.778	(8,150)
Combined Interaction	1.058	(18,96)	1.442	(32,150)

STORM 2

Concentration	2.910	(3,5)	2.393	(4,8)
Time	1.768	(3,4)	1.346	(4,4)
Conc/Time Interaction	4.189	(9,64)*	5.665	(16,100)*
Samples	4.189	(1,1)	1.257	(1,4)
Conc/Sample Interaction	5.849	(3,64)*	6.045	(4,100)*
Time/Sample Interaction	2.807	(3,64)*	3.194	(4,100)*
Combined Interaction	1.754	(9,64)	2.084	(16,100)*

*Significant

ANALYSIS OF VARIANCE (FACTORIAL DESIGN)

WALNUT CREEK 1977-78

	F Ratio (Degrees of Freedom)			
	Between Treatments		Between Treatments and Control	
	F Ratio	(d.f.)	F Ratio	(d.f.)
STORM 4 SAMPLE 1				
Concentration	2.193	(3,12)	2.487	(4,20)
Time	5.381	(4,12)*	4.426	(5,20)*
Time/Conc. Interaction	15.820	(12,40)*	21.482	(20,60)*
STORM 4 SAMPLE 8				
Concentration	5.450	(3,12)*	5.034	(4,20)*
Time	3.964	(4,12)	3.598	(5,20)*
Time/Conc. Interaction	4.662	(12,40)	6.642	(20,60)*
STORM 4 SAMPLE 11				
Concentration	6.855	(3,12)*	5.086	(4,20)*
Time	5.288	(4,12)*	3.886	(5,20)*
Time/Conc. Interaction	1.763	(12,40)	2.694	(20,60)*
STORM 4 SAMPLE 13				
Concentration	8.739	(3,12)*	5.421	(4,20)*
Time	4.763	(4,12)*	3.026	(5,20)*
Time/Conc.	4.543	(12,40)*	6.879	(20,60)*

*Significant

ANALYSIS OF VARIANCE (FACTORIAL DESIGN)

WALNUT CREEK 1976-77

STORM 3

F Ratio (Degrees of Freedom)

	Between Treatments		Between Treatments and Control	
	F Ratio	(d.f.)	F Ratio	(d.f.)
Concentration	6.719	(3,16)*	3.303	(4,26)*
Time	15.593	(4,18)*	7.178	(5,26)*
Conc/Time Interaction	11.530	(12,160)*	33.821	(20,240)*
Samples	1.117	(3,15)	1.104	(3,19)
Conc/Sample Interaction	11.099	(9,160)*	11.710	(12,240)*
Time/Samples Interaction	10.189	(12,160)	10.617	(60,240)*
Combined Interaction	2.606	(36,160)*	3.425	(60,240)*

STORM 4

	F Ratio	(d.f.)	F Ratio	(d.f.)
Concentration	1.874	(3,19)	1.924	(4,29)
Time	5.186	(4,13)*	3.976	(5,22)*
Conc/Time Interaction	15.311	(12,160)	21.547	(20,240)*
Samples	2.323	(3,10)	2.052	(3,14)
Conc/Sample Interaction	15.045	(9,160)*	16.395	(12,240)*
Time/Sample Interaction	1.893	(12,160)*	3.282	(15,240)*
Combined Interaction	1.171	(36,160)	1.820	(60,240)

*Significant

ANALYSIS OF VARIANCE (FACTORIAL DESIGN)

WALNUT CREEK 1977-78

	F Ratio (Degrees of Freedom)			
	Between Treatments		Between Treatments and Control	
	F Ratio	(d.f.)	F Ratio	(d.f.)
STORM 4 SAMPLE 1				
Concentration	2.193	(3,12)	2.487	(4,20)
Time	5.381	(4,12)*	4.426	(5,20)*
Time/Conc. Interaction	15.820	(12,40)*	21.482	(20,60)*
STORM 4 SAMPLE 8				
Concentration	5.450	(3,12)*	5.034	(4,20)*
Time	3.964	(4,12)*	3.598	(5,30)*
Time/Conc. Interaction	4.662	(12,40)*	6.642	(20,60)*
STORM 4 SAMPLE 11				
Concentration	6.855	(3,12)*	5.086	(5,20)*
Time	5.288	(4,12)*	3.886	(5,20)*
Time/Conc. Interaction	1.763	(12,40)	2.694	(20,60)*
STORM 4 SAMPLE 13				
Concentration	8.739	(3,12)*	5.421	(4,20)*
Time	4.763	(4,12)*	3.026	(5,20)*
Time/Conc. Interaction	4.543	(12,40)	6.879	(20,60)*

*Significant

ANALYSIS OF VARIANCE (FACTORIAL DESIGN)

LOS ANGELES 1976-77

F Ratio (Degrees of Freedom)

	Between Treatments F Ratio	Between Treatments (d.f.)	Between Treatments and Control F Ratio	Between Treatments and Control (d.f.)
STORM 1 SAMPLE 1				
Concentration	90.674	(3,12)*	18.979	(4,20)*
Time	4.178	(4,12)*	1.600	(5,20)
Time/Conc. Interaction	13.091	(12,40)*	62.546	(20,60)*
STORM 1 SAMPLE 5				
Concentration	43.792	(3,12)*	14.940	(4,20)*
Time	4.157	(4,12)*	1.759	(5,20)
Time/Conc. Interaction	3.511	(12,40)*	10.028	(20,60)*
STORM 1 SAMPLE 6				
Concentration	51.650	(3,12)	17.001	(4,20)*
Time	1.067	(4,12)	0.935	(5,20)
Time/Conc. Interaction	1.251	(12,40)	3.769	(20,000)*
STORM 1 SAMPLE 7				
Concentration	31.626	(3,12)*	14.449	(4,20)*
Time	2.265	(4,12)	2.268	(5,20)
Time/Conc. Interaction	3.366	(12,40)*	8.182	(20,60)*
STORM 1 SAMPLE 10				
Concentration	47.174	(3,12)*	14.469	(4,20)*
Time	6.697	(4,12)*	2.183	(5,20)
Time/Conc. Interaction	5.036	(12,40)*	15.565	(20,60)*

*Significant

ANALYSIS OF VARIANCE (FACTORIAL DESIGN)

LOS ANGELES 1976-77 (Continued)

F Ratio (Degrees of Freedom)

	Between Treatments		Between Treatments and Control	
	F Ratio	(d.f.)	F Ratio	(d.f.)
STORM 1 SAMPLE 1				
Concentration	28.952	(4,16)*	12.881	(5,25)*
Time	4.491	(4,16)*	2.477	(5,25)
Time/Conc. Interaction	2.479	(16,50)*	5.596	(25,72)*
STORM 2 SAMPLE 2				
Concentration	40.772	(4,16)*	14.061	(5,25)*
Time	9.049	(4,16)*	3.560	(5,25)*
Time/Conc. Interaction	3.009	(16,50)*	8.731	(25,72)*
STORM 2 SAMPLE 7				
Concentration	40.760	(4,16)*	15.734	(5,25)*
Time	3.392	(4,16)*	3.093	(5,25)*
Time/Conc. Interaction	2.652	(16,5)*	7.526	(25,72)*
STORM 3 SAMPLE 1 (unfiltered)				
Concentration	109.321	(4,12)*	14.271	(5,20)*
Time	2.287	(3,12)	4.562	(4,20)*
Time/Conc. Interaction	19.914	(12,40)*	181.702	(20,40)*
STORM 3 SAMPLE 1 (filtered)				
Concentration	234.494	(4,12)*	15.130	(5,20)*
Time	2.701	(3,12)	4.702	(4,20)*
Time/Conc. Interaction	16.615	(12,40)	306.164	(20,60)*

*Significant

ANALYSIS OF VARIANCE (FACTORIAL DESIGN)

LOS ANGELES 1976-77 (Continued)

F Ratio (Degrees of Freedom)

	Between Treatments F Ratio	Between Treatments (d.f.)	Between Treatments and Control F Ratio	Between Treatments and Control (d.f.)
STORM 3 SAMPLE 2 (unfiltered)				
Concentration	42.965	(4,12)*	11.905	(5,20)*
Time	3.085	(3,12)	3.090	(4,20)*
Time/Conc. Interaction	3.519	(12,40)*	13,965	(20,60)*
STORM 3 SAMPLE 2 (filtered)				
Concentration	16.570	(4,12)*	8.626	(5,20)*
Time	0.639	(3,12)	1.379	(4,20)
Time/Conc. Interaction	17.427	(12,40)*	34.937	(20,60)*
STORM 3 SAMPLE 6 (unfiltered)				
Concentration	50.496	(4,12)*	12.497	(5,20)*
Time	1.773	(3,12)	2.747	(4,20)
Time/Conc. Interaction	14.894	(12,40)*	65.757	(20,60)*
STORM 3 SAMPLE 6 (filtered)				
Concentration	170.614	(4,12)*	14.893	(5,20)*
Time	0.078	(3,12)	3.669	(4,20)*
Time/Conc. Interaction	4.209	(12,40)*	54.933	(20,60)*

*Significant

ANALYSIS OF VARIANCE (FACTORIAL DESIGN)

LOS ANGELES 1977-78

	F Ratio (Degrees of Freedom)			
	Between Treatments		Between Treatments and Control	
	F Ratio	(d.f.)	F Ratio	(d.f.)
STORM 1 SAMPLE 1				
Concentration	53.573	(3,12)*	15.856	(4,20)*
Time	6.137	(4,12)*	2.576	(5,20)
Time/Conc. Interaction	3.235	(12,40)*	11.216	(20,60)*
STORM 1 SAMPLE 2				
Concentration	41.034	(3,12)*	15.971	(4,20)*
Time	10.740	(4,12)*	6.875	(5,20)*
Time/Conc. Interaction	4.398	(12,40)*	18.806	(20,60)*
STORM 1 SAMPLE 3				
Concentration	51.674	(3,12)*	17.205	(4,20)*
Time	3.625	(4,12)*	3.332	(5,20)*
Time/Conc. Interaction	3.601	(12,40)*	12,908	(20,60)*

*Significant

ANALYSIS OF VARIANCE (FACTORIAL DESIGN)

LOS ANGELES 1976-77

	F Ratio (Degrees of Freedom)			
	Between Treatments		Between Treatments and Control	
	F Ratio	(d.f.)	F Ratio	(d.f.)
STORM 1				
Concentration	59.854	(3,17)*	16.804	(4,25)*
Time	4.163	(4,17)*	1.555	(5,23)
Conc/Time Interaction	6.468	(12,200)*	37.757	(20,300)*
Samples	1.806	(4,17)	1.672	(4,21)
Conc/Sample Interaction	8.296	(12,200)*	9.036	(16,300)*
Time/Sample Interaction	5.146	(16,200)*	5.745	(20,300)*
Combined Interaction	2.302	(48,200)*	2.742	(80,300)*
STORM 2				
Concentration	56.865	(4,9)*	16.107	(5,26)*
Time	6.733	(4,9)*	2.914	(5,26)*
Conc/Time Interaction	3.428	(16,150)*	15.436	(25,216)*
Samples	2.844	(2,7)	2.485	(2,1)
Conc/Sample Interaction	3.501	(8,50)*	3.947	(10,216)*
Time/Sample Interaction	3.888	(8,150)*	4.318	(10,216)*
Combined Interaction	2.235	(32,150)*	2.367	(50,216)*

*Significant

ANALYSIS OF VARIANCE (FACTORIAL DESIGN)

LOS ANGELES 1976-77

F Ratio (Degrees of Freedom)

	Between Treatments F Ratio	Between Treatments (d.f.)	Between Treatments and Control F Ratio	Between Treatments and Control (d.f.)
STORM 3 SAMPLE 1 - Unfiltered vs. Filtered				
Concentration	343.742	(4,4)*	15.366	(5,19)*
Time	3.094	(3,6)	4.729	(4,20)*
Conc/Time Interaction	25.387	(12,80)*	440.677	(20,120)*
Samples	0.172	(1,1)	0.187	(1,1)
Conc/Sample Interaction	2.924	(4,80)*	2.827	(5,120)*
Time/Sample Interaction	12.083	(3,80)*	11.359	(4,120)*
Combined Interaction	12.093	(12,80)*	11.513	(20,120)*
STORM 3 SAMPLE 2 - Unfiltered vs. Filtered				
Concentration	19.587	(4,5)*	9.456	(5,10)*
Time	0.566	(3,4)	1.916	(4,15)
Conc/Time Interaction	10.390	(12,80)*	35.863	(20,120)*
Samples	0.386	(1,4)	0.412	(1,5)
Conc/Sample Interaction	16.744	(4,80)*	16.421	(5,12)*
Time/Sample Interaction	12.857	(3,80)*	12.594	(4,120)*
Combined Interaction	7.215	(12,80)*	8.002	(20,120)*

*Significant

ANALYSIS OF VARIANCE (FACTORIAL DESIGN)

LOS ANGELES 1976-77

F Ratio (Degrees of Freedom)

	Between Treatments F Ratio	Between Treatments (d.f.)	Between Treatments and Control F Ratio	Between Treatments and Control (d.f.)
STORM 3 SAMPLE 6 - Unfiltered vs. Filtered				
Concentration	115.778	(4,3)*	14.385	(5,20)*
Time	0.951	(3,2)	3.198	(4,20)*
Conc/Time Interaction	9.546	(12,80)*	110.798	(20,120)*
Samples	0.195	(1,3)	0.212	(1,3)
Conc/Sample Interaction	13.444	(4,80)*	13.048	(5,120)*
Time/Sample Interaction	15.144	(3,80)*	14.419	(4,120)*
Combined Interaction	10.385	(12,80)*	10.730	(20,120)*
STORM 3				
Concentration	20.426	(4,8)*	9.249	(5,25)*
Time	2.836	(3,4)	3.478	(4,22)*
Conc/Time Interaction	6.565	(12,120)*	90.088	(20,180)*
Samples	3.860	(2,9)	3.002	(2,12)
Conc/Sample Interaction	57.003	(8,120)*	64.063	(10,180)*
Time/Sample Interaction	10.153	(6,120)*	24.112	(8,180)*
Combined Interaction	6.664	(24,120)*	10.382	(40,180)*

*Significant

ANALYSIS OF VARIANCE (FACTORIAL DESIGN)

LOS ANGELES 1977-78

F Ratio (Degrees of Freedom)

	Between Treatments		Between Treatments and Control	
	F Ratio	(d.f.)	F Ratio	(d.f.)
Concentration	9.230	(3,7)*	7.660	(4,17)*
Time	6.902	(4,12)*	3.949	(5,20)*
Conc/Time Interaction	5.758	(12,120)*	29.046	(20,180)*
Samples	0.161	(2,7)	0.175	(2,8)
Conc/Sample Interaction	44.258	(6,120)*	41.959	(8,180)*
Time/Sample Interaction	4.546	(8,120)*	4.663	(10,180)*
Combined Interaction	2.276	(23,120)*	3.980	(40,180)*

*Significant

ANALYSIS OF VARIANCE (FACTORIAL DESIGN)

SLOPES

	F Ratio (Degrees of Freedom)			
	Between Treatments		Between Treatments and Control	
	F Ratio	(d.f.)	F Ratio	(d.f.)
SLOPE 1 SAMPLE 1 (unfiltered)				
Concentration	3.779	(3,12)*	3.232	(4,20)*
Time	2.529	(4,12)	2.202	(5,20)
Time/Conc. Interaction	4.913	(12,40)*	5.934	(20,60)*
SLOPE 2 SAMPLE 1 (unfiltered)				
Concentration	6.129	(3,12)*	4.251	(4,20)*
Time	11.505	(4,12)*	6.545	(5,20)*
Time/Conc. Interaction	3.883	(12,40)*	7.441	(20,60)*
SLOPE 1 SAMPLE 2 (unfiltered)				
Concentration	0.465	(3,6)	3.659	(4,20)*
Time	31.092	(2,6)*	12,730	(3,12)*
Time/Conc. Interaction	1.947	(6,24)	8.402	(12,40)*
SLOPE 1 SAMPLE 2 (filtered)				
Concentration	1.293	(3,6)	1.288	(4,12)
Time	2.986	(2,6)	2.717	(3,12)
Time/Conc. Interaction	1.254	(6,24)	1.462	(12,40)
SLOPE 2 SAMPLE 2 (unfiltered)				
Concentration	23.348	(3,6)*	5.065	(4,12)*
Time	22.415	(2,6)*	5.011	(3,12)*
Time/Conc. Interaction	1.108	(6,24)	5.270	(12,40)*
SLOPE 2 SAMPLE 2 (filtered)				
Concentration	0.568	(3,6)	1.789	(4,12)
Time	0.033	(2,6)	2.302	(3,12)
Time/Conc. Interaction	5.762	(6,24)	6.007	(12,40)*

*Significant

ANALYSIS OF VARIANCE (FACTORIAL DESIGN)

SLOPE 1 AND 2 - SAMPLE 1

F Ratio (Degrees of Freedom)

	Between Treatments		Between Treatments and Control	
	F Ratio	(d.f.)	F Ratio	(d.f.)
Concentration	1.717	(3,4)	1.120	(4,5)
Time	1.273	(4,4)	1.073	(5,6)
Conc/Time Interaction	4.976	(12,80)*	8.093	(20,120)*
Samples	4.036	(1,6)	3.096	(1,7)
Conc/Sample Interaction	15.486	(3,80)*	25.065	(4,120)*
Time/Sample Interaction	29.751	(4,80)*	35.311	(5,120)*
Combined Interaction	3.421	(12,80)*	5.866	(20,120)*

SLOPE 1 AND 2 (Unfiltered vs. Filtered)

Concentration	0.595	(3,3)	1.369	(4,5)
Time	2.483	(2,2)	2.052	(3,4)
Conc/Time Interaction	1.667	(6,48)	4.637	(12,80)*
Samples	8.439	(1,2)	3.768	(1,4)
Conc/Sample Interaction	1.606	(3,48)	8.043	(4,80)*
Time/Sample Interaction	12.064	(2,48)*	22.345	(3,80)*
Combined Interaction	1.274	(6,48)	2.626	(12,80)*

*Significant

ANALYSIS OF VARIANCE (FACTORIAL DESIGN)

SLOPE 2 SAMPLE 2 (Unfiltered vs. Filtered)

F Ratio (Degrees of Freedom)

	Between Treatments		Between Treatments and Control	
	F Ratio	(d.f.)	F Ratio	(d.f.)
Concentration	0.818	(3,3)	1.270	(4,4)
Time	0.952	(2,2)	1.963	(3,3)
Conc/Time Interaction	2.881	(6,48)*	5.726	(12,80)*
Samples	0.169	(1,4)	0.197	(1,5)
Conc/Sample Interaction	18.443	(3,48)*	17.615	(4,80)*
Time/Sample Interction	15.277	(2,48)*	14.156	(3,80)*
Combined Interaction	3.131	(6,48)*	5.415	(12,80)*

SLOPE 1 AND 2 SAMPLE 2 (Unfiltered)

Concentration	0.663	(3,4)	1.592	(4,4)
Time	0.263	(2,2)	0.817	(3,3)
Conc/Time Interaction	2.234	(6,48)	6.775	(12,80)*
Samples	1.471	(1,3)	1.364	(1,4)
Conc/Sample Interaction	15.650	(3,48)*	22.204	(4,80)*
Time/Sample Interaction	67.087	(2,48)*	73.024	(3,80)*
Combined Interaction	0.815	(6,48)	6.873	(12,80)*

*Significant

APPENDIX C

Bioassay Results

1976-77 PLACERVILLE

STORM 2 SAMPLE 1 - Unfiltered

Algal Assay: Counts/Minute

Treatment		24	48	72	96	120
Control	$\bar{x}$	4435.0	5663.7		7282.3	8312.7
	s	493.3	160.4		111.1	173.4
.1%	$\bar{x}$	4018.7*	4722.0*		5801.0*	7466.3*
	s	126.2	777.9		213.5	199.3
1%	$\bar{x}$	3719.7*	3851.7*		6678.0*	9451.3
	s	305.6	541.5		309.2	1439.3
5%	$\bar{x}$	2262.7*	2889.0		3788.3	6048.9
	s	529.6	1113.5		1936.3	1037.9
10%	$\bar{x}$	1777.3*	2516.7*		2799.3*	3753.0*
	s	475.1	414.5		1139.6	1059.1

(Hours: 24, 48, 72, 96, 120)

STORM 2 SAMPLE 1 - Filtered

Treatment		24	48	72	96	120
Control	$\bar{x}$	4435.0	5663.7		7282.3	8312.7
	s	493.3	160.4		111.1	173.4
.1%	$\bar{x}$	3572.0	4338.7*		5722.3*	6616.3*
	s	58.6	433.6		408.6	295.8
1%	$\bar{x}$	3828.3	4581.0		5940.0	7756.7
	s	499.7	882.6		1619.6	1023.4
5%	$\bar{x}$	2484.0*	3175.3*		4410.3	6537.3*
	s	270.0	379.4		1536.6	383.3
10%	$\bar{x}$	1756.0*	2170.3*		3604.0	5467.0*
	s	326.7	581.2		1300.4	137.8

* = Significant difference from control at 95% confidence level

1976-77 PLACERVILLE

STORM 2 SAMPLE 2 - Unfiltered

Algal Assay: Counts/Minute

Treatment		Hours 24	48	72	96	120
Control	$\bar{x}$	4214.7	5103.0		7294.0	8098.7
	s	345.2	73.5		726.2	391.9
.1%	$\bar{x}$	4419.3	5836.7		7216.7	8341.0
	s	607.8	630.9		1031.1	309.3
1%	$\bar{x}$	4496.3	6195.7*		7002.7	8845.0*
	s	457.8	306.3		324.9	210.1
5%	$\bar{x}$	3097.3*	5358.0		7957.7	14615.3*
	s	195.4	550.7		511.2	159.5
10%	$\bar{x}$	2045.7*	3219.0*		4099.0	7794.3
	s	165.4	21.4		810.8	720.6

STORM 2 SAMPLE 1 - Filtered

Treatment		24	48	72	96	120
Control	$\bar{x}$	4217.7	5103.0		7294.0	8098.7
	s	345.2	73.5		726.2	391.9
.1%	$\bar{x}$	4444.3	4950.3		7149.0	8881.7
	s	410.0	720.4		801.1	899.9
1%	$\bar{x}$	4401.3	5309.0		7791.7	11330.0*
	s	242.4	384.8		1427.5	221.6
5%	$\bar{x}$	3431.7*	4995.7		1427.5*	12295.3*
	s	129.6	1043.7		736.5	319.7
10%	$\bar{x}$		3563.0*		5299.7*	10720.3*
	s		420.9		611.7	380.7

* = Significant difference from control at 95% confidence level

1976-77 PLACERVILLE

STORM 2 SAMPLE 6 - Unfiltered

Algal Assay: Counts/Minute

Treatment		Hours 24	48	72	96	120
Control	$\bar{x}$	4214.7	5103.0		7294.0	8098.7
	s	345.2	73.5		726.2	391.9
.1%	$\bar{x}$	4408.0	6417.7*		7895.3	10550.0*
	s	194.8	272.3		498.3	609.8
1%	$\bar{x}$	4238.7	5823.0*		7913.7	10209.0*
	s	100.9	281.8		688.4	279.1
5%	$\bar{x}$	3450.7*	4832.7*		7824.7	11835.0*
	s	115.7	108.1		381.6	1147.5
10%	$\bar{x}$	3272.7*	4350.3*		6390.7	9121.0*
	s	513.7	129.9		446.2	124.3

STORM 2 SAMPLE 10 - Unfiltered

Treatment		24	48	72	96	120
Control	$\bar{x}$	4214.7	5103.0		7294.0	8098.7
	s	345.2	73.5		726.2	391.9
.1%	$\bar{x}$	4242.0	6334.0*		7732.3	9901.7*
	s	172.7	215.6		925.1	98.0
1%	$\bar{x}$	4000.0	6003.3*		7707.7	10315.7*
	s	27.7	100.7		427.5	319.1
5%	$\bar{x}$	4119.0	5174.3		8286.7	11939.0*
	s	153.0	385.2		524.3	779.2
10%	$\bar{x}$	2942.0*	4067.3*		5077.0*	9806.3
	s	76.4	107.8		88.3	192.5

* = Significant difference from control at 95% confidence level

1976-77 PLACERVILLE

STORM 3 SAMPLE 1 - Unfiltered

Algal Assay: Counts/Minute

Treatment		24	48	72	96	120
Control	$\bar{x}$		2849.3	4494.3	4323.0	4608.7
	s		99.9	52.7	171.1	810.3
.1%	$\bar{x}$		2672.0	2932.0*	7386.0	6356.3*
	s		45.0	184.0	1324.0	356.1
1%	$\bar{x}$		2623.0*	4130.0	5774.5	6635.0*
	s		45.1	364.6	610.2	864.1
5%	$\bar{x}$		2108.0*	4565.0	6635.0*	6712.0*
	s		30.6	91.6	86.4	63.6
10%	$\bar{x}$		1564.0*	4453.0	5901.0*	6386.0*
	s		123.1	404.5	123.0	459.6

STORM 3 SAMPLE 5 - Unfiltered

Treatment		24	48	72	96	120
Control	$\bar{x}$		2849.3	4494.3	4323.0	4608.7
	s		99.9	52.7	171.1	810.3
.1%	$\bar{x}$		2474.0	3043.0	4430.5	4024.5
	s		240.0	313.7	221.3	34.6
1%	$\bar{x}$		2539.0	3030.0	4962.0*	5217.0
	s		188.2	26.2	347.2	479.4
5%	$\bar{x}$		2911.0	3784.0*	6600.5*	9111.5*
	s		431.9	541.6	129.8	248.6
10%	$\bar{x}$		2591.7	6725.3*	6262.0*	6692.5*
	s		989.2	157.9	387.5	221.3

* = Significant difference from control at 95% confidence level

1976-77 PLACERVILLE

STORM 3 SAMPLE 8 - Unfiltered

Algal Assay: Counts/Minute

Treatment		Hours 24	48	72	96	120
Control	$\bar{x}$		2386.7	4051.7	4083.3	4003.7
	s		168.0	230.0		
.1%	$\bar{x}$		2330.7	4215.3	6336.0	4645.0
	s		76.1	359.2	256.2	86.6
1%	$\bar{x}$		2786.0	3992.3	4950.5	6108.3
	s		269.9	227.9	34.6	312.9
5%	$\bar{x}$		2607.7	4559.3	6064.0	8173.0
	s		175.8	31.5	207.9	868.3
10%	$\bar{x}$		2119.0	7429.0*	6817.0	7551.7
	s		27.6	656.9	387.0	179.7

STORM 3 SAMPLE 5 - Unfiltered

Treatment		24	48	72	96	120
Control	$\bar{x}$		2849.3	4494.3	4323.0	4608.7
	s		99.9	52.7	171.1	810.3
.1%	$\bar{x}$		2472.0	3043.0*	4430.5	4024.5
	s		240.0	313.7	221.3	34.6
1%	$\bar{x}$		2539.0	3030.0*	4962.0*	5217.0*
	s		188.3	26.2	347.2	479.4
5%	$\bar{x}$		2911.0	3784.0	6600.5*	9111.5*
	s		431.9	541.6	129.8	248.6
10%	$\bar{x}$		2591.7	6725.3*	6262.0*	6692.5*
	s		989.2	157.9	387.5	221.3

* = Significant difference from control at 95% confidence level

1976-77 PLACERVILLE

STORM 3 SAMPLE 10 - Unfiltered

Algal Assay: Counts/Minute

Treatment		24	48	72	96	120
Control	$\bar{x}$		2386.7	4051.7	4083.3	4403.7
	s		168.0	230.0	605.8	231.5
.1%	$\bar{x}$		2399.5	3132.3*	3767.3	4562.3
	s		251.0	311.1	407.6	747.5
1%	$\bar{x}$		2691.5	3179.3*	5286.0*	5446.3
	s		365.6	77.4	504.9	1107.7
5%	$\bar{x}$		2522.5	3865.0	4888.3	5297.3
	s		67.2	389.8	511.9	578.1
10%	$\bar{x}$		2110.5	7180.3*	5892.0*	6503.0*
	s		222.7	203.3	561.4	879.6

(Hours)

1976-77 WALNUT CREEK

STORM 1 SAMPLE 2 - Unfiltered

Control	$\bar{x}$		12734.7	13073.7	12503.5	10899.3
	s		674.9	775.6	274.2	1674.3
.1%	$\bar{x}$		12661.7	12072.7	12559.7	12270.0
	s		1897.5	1695.9	370.1	682.6
1%	$\bar{x}$		13458.0	12764.7	12997.0	12239.0
	s		1861.5	1018.1	439.2	897.8
10%	$\bar{x}$		11969.7	14359.3	15019.7	14161.3
	s		2006.9	1236.0	1444.1	2039.3

* = Significant from controls

1976-77 WALNUT CREEK

STORM 1 SAMPLE 4 - Unfiltered

Algal Assay: Counts/Minute

Treatment		24	48	72	96	120
				Hours		
Control	$\bar{x}$		12734.7	13073.7	12503.3	10899.3
	s		674.9	775.6	274.2	1674.2
.01%	$\bar{x}$		13346.3	12864.3	13158.0	11242.7
	s		1220.3	1417.9	1681.5	329.2
.1%	$\bar{x}$		13235.3*	11241.3*	12222.0	11997.3
	s		2079.6	357.1	1571.2	239.8
10%	$\bar{x}$		13698.0	16189.0	17547.0	17647.3*
	s		2143.8	1822.1	308.0	1697.0

STORM 2 SAMPLE 2 - Unfiltered

Treatment		24	48	72	96	120
Control	$\bar{x}$		11287.3	11811.3	11575.3	13518.3
	s		1986.6	1515.5	1439.1	321.0
.01%	$\bar{x}$		10445.3	9841.3	10016.7	12828.0
	s		661.4	1010.5	501.2	1862.9
.1%	$\bar{x}$		11704.7	12900.7	12669.0	13440.0
	s		1487.5	1542.3	3406.9	952.5
1%	$\bar{x}$		12566.3	14733.0*	13008.0	14966.3
	s		1097.4	766.3	1858.1	940.7
10%	$\bar{x}$		7860.0	9656.0	11806.0	13567.0
	s		55.6	139.3	1932.1	1576.4

*Significant from controls

1976-77 WALNUT CREEK

STORM 3 SAMPLE 3 - Unfiltered

Algal Assay: Counts/Minute

Treatment		Hours 24	48	72	96	120
Control	$\bar{x}$	6281.3	5787.3	5544.0	5671.3	6028.7
	s	421.7	686.9	396.3	48.9	93.8
.01%	$\bar{x}$	5953.7	5921.3	7234.7	7348.0*	8271.7*
	s	106.5	197.0	1031.1	137.8	292.1
.1%	$\bar{x}$	5634.0	5748.0	6251.0	7146.0*	8704.3*
	s	223.4	88.1	103.9	185.9	336.8
1%	$\bar{x}$	5753.7	6038.0	6688.3*	6507.3	7815.0*
	s	236.2	349.7	466.4	357.3	158.9
10%	$\bar{x}$	4067.3*	3826.3*	4257.0*	6212.3*	7256.3*
	s	117.7	109.1	109.0	102.8	322.1

STORM 3 SAMPLE 8 - Unfiltered

Treatment		24	48	72	96	120
Control	$\bar{x}$	6281.3	5787.3	5544.0	5671.3	6028.7
	s	421.7	686.9	396.3	48.9	92.8
.01%	$\bar{x}$	5055.0*	5296.7	6415.3*	7251.3*	7765.3*
	s	186.7	213.5	221.5	233.2	400.1
.1%	$\bar{x}$	4696.0*	6330.3	6063.3	6715.7*	7675.0
	s	95.1	107.2	158.3	208.3	705.3
1%	$\bar{x}$	5079.3*	5920.0	6683.0*	6809.3*	8003.3*
	s	473.0	163.4	401.2	260.5	192.0
10%	$\bar{x}$	3877.3*	4484.7	5598.3	6949.0*	8700.0*
	s	94.9	60.0	314.9	128.7	227.0

* = Significant from controls

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STORM 2 SAMPLE 5 - Unfiltered

Algal Assay: Counts/Minute

Treatment		24	48	72	96	120
Control	$\bar{x}$		11287.3	11811.3	11575.3	13518.3
	s		1986.6	1515.5	1439.2	321.0
.01%	$\bar{x}$		12019.0	13578.7	15387.7	14310.0
	s		590.3	283.6	243.6	729.2
.1%	$\bar{x}$		11972.7	12860.3	12180.0	14453.0
	s		1501.4	890.9	1519.5	813.1
1%	$\bar{x}$		11643.0	13968.7	15177.3*	18109.7*
	s		2072.7	1678.2	1490.8	1018.8
10%	$\bar{x}$		5481.7*	9450.0	10962.3	16363.0*
	s		76.9	106.6	205.2	249.3

STORM 3 SAMPLE 1 - Unfiltered

Treatment		24	48	72	96	120
Control	$\bar{x}$	6281.3	5787.3	5544.0	5671.3	6028.7
	s	421.7	686.9	396.3	48.9	92.8
.01%	$\bar{x}$	5618.7	5588.3	6079.3	4926.8*	7708.7*
	s	63.0	113.0	371.3	177.7	437.3
.1%	$\bar{x}$	5321.0*	6028.0	6062.3	6804.0*	8215.3*
	s	130.6	196.4	133.7	123.4	475.5
1%	$\bar{x}$	5618.3	6334.0	6373.0*	6997.0*	7876.3*
	s	31.5	215.6	184.3	221.8	162.7
10%	$\bar{x}$	3165.3*	3311.0*	5291.7	7331.0*	6334.0
	s	55.1	19.1	73.9	151.9	215.6

* = Significant from controls

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STORM 3 SAMPLE 15- Unfiltered

Algal Assay: Counts/Minute

Treatment		Hours 24	48	72	96	120
Control	$\bar{x}$	6281.3	5787.3	5544.0	5671.3	6028.7
	s	421.7	686.9	396.3	48.9	92.8
.01%	$\bar{x}$	5824.0	5623.7	7347.0*	7737.0*	8212.0
	s	1253.7	483.4	704.9	157.8	969.9
.1%	$\bar{x}$	5631.0	7231.0	7352.0*	7112.0*	6281.0
	s	943.5	152.4	623.2	139.6	493.9
1%	$\bar{x}$	6025.3	6668.3	7304.0*	7671.7	6800.3
	s	198.4	244.9	487.4	969.3	683.0
10%	$\bar{x}$	2760.7*	4355.3*	6697.0*	7198.7*	7252.3*
	s	214.9	476.1	68.1	222.2	297.7

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STORM 4 SAMPLE 1 - Unfiltered

Treatment		24	48	72	96	120
Control	$\bar{x}$	3023.7	2690.0	3067.3	5863.0	3176.7
	s	232.0	209.4	16.2	178.6	161.4
.1%	$\bar{x}$	3430.0	2679.0	3294.0	5898.0	3659.0*
	s	24.7	47.7	244.9	650.9	167.1
1%	$\bar{x}$	2730.0	2763.0	3638.0*	6726.7*	3958.0*
	s	31.2	215.5	111.7	391.1	36.8
5%	$\bar{x}$	2496.0*	3336.0*	4464.0*	7610.0*	5354.0*
	s	149.0	349.9	202.4	885.0	512.7
10%	$\bar{x}$	2242.0*	2959.0*	4454.3*	7940.3*	5980.3*
	s	175.6	245.7	257.7	535.9	200.5

* = Significant from controls

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STORM 4 SAMPLE 8 - Unfiltered

Algal Assay: Counts/Minute

Treatment		24	48	72	96	120
Control	$\bar{x}$	3023.7	2690.0	3067.3	5863.0	3176.7
	s	232.0	209.4	16.2	178.6	161.4
.1%	$\bar{x}$	2774.7	2680.3	2917.7	6499.7	3119.0
	s	458.2	508.9	212.8	926.0	439.6
1%	$\bar{x}$	3095.0	3336.0	3696.3	7555.7	3931.0*
	s	161.6	744.6	825.5	1156.7	163.6
5%	$\bar{x}$	3074.7	3853.7*	4558.0*	8302.3*	5726.7*
	s	174.1	394.9	102.3	688.3	330.7
10%	$\bar{x}$	2683.3	3270.3*	4705.3*	8914.0*	6787.3*
	s	169.2	101.3	269.5	900.7	568.8

(Hours: 24, 48, 72, 96, 120)

STORM 4 SAMPLE 11 - Unfiltered

Treatment		24	48	72	96	120
Control	$\bar{x}$	2961.3	2575.7	3127.0	7017.7	3542.3
	s	9.8	234.2	154.7	501.3	38.3
.1%	$\bar{x}$	2784.0	3124.3	3265.7	6363.0	3610.3
		647.4	339.8	79.8	265.2	745.6
1%	$\bar{x}$	3153.3	3103.0*	3675.3	8009.7	4642.0
	s	235.6	278.9	534.0	954.0	872.9
5%	$\bar{x}$	2875.7	3361.0*	4434.7*	9337.0*	5195.0
	s	360.8	65.3	151.4	289.4	322.5
10%	$\bar{x}$	1963.0*	2403.3	3254.3	7030.7	4766.7*
	s	201.0	38.6	137.7	132.0	387.2

* = Significant from controls

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STORM 4 SAMPLE 13 - Unfiltered

Algal Assay: Counts/Minute

Treatment		Hours 24	48	72	96	120
Control	$\bar{x}$	2961.3	2575.7	2127.0	7017.7	3542.3
	s	9.8	234.5	154.7	501.3	38.2
.1%	$\bar{x}$	2542.0	2571.3	2697.0	5789.7	3100.0
	s	488.8	272.2	494.3	883.6	730.2
1%	$\bar{x}$	2763.7	2945.3	4038.0*	8004.0*	4459.0
	s	391.0	283.0	421.5	187.4	510.1
5%	$\bar{x}$	2230.0*	2982.0	4320.0*	8180.0*	5974.7*
	s	286.4	333.9	384.3	257.5	303.0
10%	$\bar{x}$	1623.0*	1751.3*	2625.3*	5671.5*	4014.7*
	s	100.9	30.4	200.4	498.5	159.3

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STORM 1 SAMPLE 1 - Unfiltered

Control	$\bar{x}$	6281.3	5787.3	5544.0	5671.3	5497.0
	s	421.9	686.9	396.3	48.9	171.0
.01%	$\bar{x}$	6378.3	6152.3	5595.3	6194.7	6638.3*
	s	288.1	407.6	280.1	295.6	396.2
.1%	$\bar{x}$	5952.3	5761.3	5959.3	5683.7	5655.7
	s	35.5	352.4	254.0	117.2	223.6
1%	$\bar{x}$	4260.3*	4135.0	5749.7	5183.3*	6394.0
	s	181.7	131.0	153.7	123.9	474.9
10%	$\bar{x}$	1188.3*	1036.7*	1713.0*	1590.7*	1787.0*
	s	41.3	66.0	39.4	48.0	57.7

* = Significant from controls

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STORM 1 SAMPLE 5 - Unfiltered

Algal Assay: Counts/Minute

Treatment		24	48	72	96	120
				Hours		
Control	$\bar{x}$	6281.3	5787.3	5544.0	5671.3	5497.0
	s	421.9	686.9	396.3	48.9	171.9
.01%	$\bar{x}$	5748.3	5780.3	7183.7	5883.0	6433.7*
	s	80.8	307.4	917.3	568.8	122.6
.1%	$\bar{x}$	6239.7	5811.7	5677.0	5520.0	6715.0*
	s	168.7	274.8	483.1	634.4	126.8
1%	$\bar{x}$	3929.3*	5022.7	7653.0*	5765.0	6111.0
	s	489.3	411.6	478.2	1087.0	978.4
10%	$\bar{x}$	1464.3*	1680.0*	2026.0*	1772.7*	1612.7*
	s	87.4	164.9	198.5	191.7	128.7

STORM 1 SAMPLE 6 - Unfiltered

Treatment		24	48	72	96	120
Control	$\bar{x}$	5521.7	6295.7	6838.0	7055.0	6777.3
	s	483.3	243.3	209.7	421.4	238.5
.01%	$\bar{x}$	5579.7	5710.3	6743.0	5917.0*	6333.3
	s	544.8	499.9	778.4	443.4	629.5
.1%	$\bar{x}$	5805.0	6184.0	7253.3	6484.7	6792.0
	s	966.8	822.8	1483.7	1106.1	220.9
1%	$\bar{x}$	4942.7	6604.7	7868.0	7967.0	8652.3
	s	506.2	648.4	628.8	1208.6	975.1
10%	$\bar{x}$	1774.0*	2229.7*	3734.3*	3940.0*	2521.0*
	s	47.3	512.2	160.4	221.4	246.1

* = Significant from controls

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STORM 1 SAMPLE 7 - Unfiltered

Algal Assay: Counts/Minute

Treatment		Hours 24	48	72	96	120
Control	$\bar{x}$	5521.7	6295.7	6838.0	7055.0	6777.3
	s	483.3	243.4	209.7	421.4	238.5
.01%	$\bar{x}$	5052.6	5621.3*	5179.7*	5751.7	5479.0*
	s	459.1	164.6	240.8	372.9	569.9
.1%	$\bar{x}$	5482.0	5489.7	5983.0	6630.0	9193.7*
	s	50.8	695.3	532.0	133.1	189.9
1%	$\bar{x}$	4671.0	4820.7*	5636.0*	6830.7	6867.0
	s	367.7	304.3	250.8	114.8	116.0
10%	$\bar{x}$	1639.7*	1791.0*	2738.0*	3268.3*	3067.7*
	s	54.4	108.1	112.0	48.9	24.9

STORM 1 SAMPLE 10 - Unfiltered

Control	$\bar{x}$	6281.3	5787.3	5544.0	5671.3	5497.0
	s	421.9	686.9	396.3	48.9	171.9
.01%	$\bar{x}$	5217.3*	6385.0	6308.0	6266.0	6294.7*
	s	266.7	380.7	422.9	695.9	222.4
.1%	$\bar{x}$	5708.7	6809.3	6584.3*	7463.0*	6632.3*
	s	730.0	260.5	225.7	111.5	315.2
1%	$\bar{x}$	4723.7*	5032.0	6266.3	7729.3*	7594.7*
	s	224.0	227.6	392.8	665.9	461.8
10%	$\bar{x}$	2310.0*	2840.0*	2265.3*	2764.0*	2908.0*
	s	42.5	175.8	103.1	84.0	67.8

* = Significant from controls

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STORM 2 SAMPLE 1 - Unfiltered

Algal Assay: Counts/Minute

Treatment		Hours 24	48	72	96	120
Control	$\overline{x}$	945.0	854.3	1087.3	1084.7	1015.0
	s	56.6	13.4	199.4	9.1	121.1
.01%	$\overline{x}$		1369.0	1033.0	1041.7	1207.0
	s		403.2	56.8	18.6	71.7
.1%	$\overline{x}$		1060.0	1174.7	1064.7	1278.3
	s		183.8	216.5	61.5	208.5
1%	$\overline{x}$	1032.3	915.7	900.3	919.0	916.3
	s	53.5	88.8	114.3	149.7	42.5
5%	$\overline{x}$	1598.6	702.3	633.7*	684.3*	635.3*
	s	31.1	61.6	68.4	25.7	76.6
10%	$\overline{x}$	403.3	426.7*	452.0*	493.7*	516.7*
	s	33.9	93.8	91.0	66.4	11.7

STORM 2 SAMPLE 2 - Unfiltered

Treatment		24	48	72	96	120
Control	$\overline{x}$	945.0	854.3	1078.3	1084.7	1015.0
	s	56.6	13.4	199.4	9.1	121.1
.01%	$\overline{x}$	858.0	981.0	1066.7	1380.3	1144.0
	s	45.5	107.9	17.9	139.0	68.4
.1%	$\overline{x}$	878.0	974.3	1016.3	1016.3	1215.3
	s	107.2	64.9	116.4	112.2	105.9
1%	$\overline{x}$	870.3	1058.3*	1106.7	1085.7	1082.7
	s	69.1	31.0	113.3	86.1	77.1
5%	$\overline{x}$	461.7*	767.7	810.7	842.0*	963.0
	s	53.8	88.5	94.9	89.9	52.8
10%	$\overline{x}$	406.7*	475.7*	525.7*	595.3*	648.7*
	s	22.1	28.0	44.8	65.7	61.3

*Significant from Control

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STORM 2 SAMPLE 7 - Unfiltered

Algal Assay: Counts/Minute

Treatment		Hours 24	48	72	96	120
Control	$\bar{x}$	945.0	854.3	1087.3	1084.7	1015.0
	s	56.6	13.4	199.4	9.1	121.1
.01%	$\bar{x}$	778.7	943.0	1032.3	1161.3	1127.7
	s	96.5	68.1	204.6	97.9	28.9
.1%	$\bar{x}$	861.0	1010.0	924.0	885.0	1001.7
	s	79.8	151.6	66.5	186.7	91.7
1%	$\bar{x}$	829.7*	868.3	1054.7	1053.7	1090.7
	s	54.8	69.6	40.8	41.8	8.9
5%	$\bar{x}$	537.3*	623.7*	705.7*	644.7*	602.3*
	s	36.8	55.2	100.4	73.1	28.0
10%	$\bar{x}$	476.7*	410.0*	502.7*	483.0*	461.7*
	s	73.1	57.5	59.3	49.3	31.6

STORM 3 SAMPLE 1 - Unfiltered

Treatment		48	72	96	120
Control	$\bar{x}$	7588.0	8549.3	6689.0	8404.0
	s	1035.9	207.3	31.1	100.4
.01%	$\bar{x}$	6303.0	6969.0*	7922.3	8138.3
	s	730.7	770.8	577.8	374.1
.1%	$\bar{x}$	7183.3	7678.7*	7484.0*	10712.7*
	s	261.8	265.3	182.1	245.6
1%	$\bar{x}$	793.6*	804.3*	895.7*	1115.3*
	s	69.0	50.1	76.5	113.2
5%	$\bar{x}$	292.7*	265.0*	268.0*	318.7*
	s	16.0	14.5	11.1	25.8
10%	$\bar{x}$	188.3*	176.3*	167.7*	228.3*
	s	11.2	10.0	6.4	28.4

*Significant from Control

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STORM 3 SAMPLE 1 - Filtered

Algal Assay: Counts/Minute

Treatment		24	48	72	96	120
				Hours		
Control	$\bar{x}$		7588.0	8549.3	6689.0	8404.0
	s		1035.9	207.3	31.1	100.4
.1%	$\bar{x}$		7292.7	7828.7	7163.0	10037.7*
	s		710.5	641.5	191.5	254.6
1%	$\bar{x}$		797.7*	779.0*	882.3*	1100.0*
	s		42.4	63.4	54.1	79.3
5%	$\bar{x}$		332.3*	370.0*	364.0*	339.0*
	s		11.9	50.7	46.9	70.9
10%	$\bar{x}$		213.7*	247.7*	218.0*	279.3*
	s		20.7	52.4	30.8	26.6

STORM 3 SAMPLE 2 - Unfiltered

Control	$\bar{x}$		6076.7	6633.7	6518.3	8995.0
	s		126.5	850.1	696.9	701.8
.01%	$\bar{x}$		5015.0	6692.7	6165.7	8363.0
	s		543.1	510.7	404.4	280.0
.1%	$\bar{x}$		6443.7	9275.3	6737.0	8599.0
	s		437.5	1525.6	326.7	1429.4
1%	$\bar{x}$		2786.7*	5832.3	6413.7	7833.3
	s		1250.4	1716.8	662.8	1124.1
5%	$\bar{x}$		1053.4*	2397.3*	2191.3*	2543.5*
	s		91.9	106.2	104.4	502.8
10%	$\bar{x}$		1139.0*	1661.0*	1543.7*	1678.3*
	s		152.7	189.9	160.1	76.9

*Significant from controls

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STORM 3 SAMPLE 2 - Filtered

Algal Assay: Counts/Minute

Treatment		24	48	72	96	120
Control	$\bar{x}$		6076.7	6633.7	6518.7	8995.0
	s		126.5	850.1	696.9	701.8
.01%	$\bar{x}$		6921.3	6484.3	6403.3	6107.0*
	s		1340.1	213.3	447.6	555.6
.1%	$\bar{x}$		6421.3	6697.2	6107.0	7947.0
	s		496.5	773.1	555.6	1290.5
1%	$\bar{x}$		4520.7*	6221.6	5370.7	7075.3*
	s		326.6	595.0	727.8	861.4
5%	$\bar{x}$		1992.0*	2207.0*	2322.0*	3339.3*
	s		14.4	239.6	147.5	379.8
10%	$\bar{x}$		1260.3*	1754.3*	1594.7*	2236.0
	s		210.9	266.0	367.9	356.8

STORM 3 SAMPLE 6 - Unfiltered

Treatment		24	48	72	96	120
Control	$\bar{x}$		6076.7	6633.7	6518.3	8993.0
	s		126.5	850.1	696.9	701.8
.01%	$\bar{x}$		5274.0*	6949.7	6591.3	10020.3
	s		290.9	241.5	353.2	550.5
.1%	$\bar{x}$		5819.7	8480.0*	6855.0	8784.3
	s		219.9	256.2	249.4	399.2
1%	$\bar{x}$		3742.0*	4757.7	5614.7	8861.7
	s		243.5	204.6	485.0	1115.8
5%	$\bar{x}$		2138.0*	2552.0*	2710.7*	2773.7*
	s		137.1	63.9	59.0	119.1
10%	$\bar{x}$		1479.7*	1782.0*	2017.7*	1966.3*
	s		36.0	228.4	235.9	71.8

*Significant from controls

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STORM 3 SAMPLE 6 - Filtered

Algal Assay: Counts/Minute

Treatment		Hours 24	48	72	96	120
Control	$\bar{x}$		6076.7	6833.7	6518.3	8993.0
	s		126.5	850.1	696.9	701.8
.01%	$\bar{x}$		6222.0	6638.0	6959.7	9202.0
	s		322.4	396.2	368.8	625.3
.1%	$\bar{x}$		5994.0	6221.7	5685.7	8353.0
	s		237.8	254.3	181.2	503.0
1%	$\bar{x}$		4585.7*	5823.7	4814.3	7317.0*
	s		370.7	287.3	462.7	447.4
5%	$\bar{x}$		2250.0*	2025.7*	2647.7	3936.7*
	s		93.2	63.8	92.5	302.4
10%	$\bar{x}$		1777.3*	1834.0*	2002.0	2320.7*
	s		52.5	84.0	78.0	43.4

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STORM 1 SAMPLE 1 - Unfiltered

Treatment		24	48	72	96	120
Control	$\bar{x}$	2479.0	3444.3	4866.3	11668.0	12053.0
	s	130.1	341.1	500.4	822.5	290.5
.1%	$\bar{x}$	3186.0*	4034.0	5151.0	13095.3	17280.0
	s	100.4	524.7	318.2	1683.6	6305.9
1%	$\bar{x}$	3788.7	3139.0	3537.0*	8940.0*	12196.3
	s	879.3	166.9	325.9	451.1	149.0
5%	$\bar{x}$	1851.7*	1767.3*	1903.7*	4527.0*	5056.3*
	s	222.7	149.0	25.8	447.0	206.3
10%	$\bar{x}$	1169.0*	1019.7*	946.0*	2706.0*	2733.0*
	s	41.0	19.7	50.4	616.3	63.6

*Significant from controls

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STORM 1 SAMPLE 2 - Unfiltered

Algal Assay: Counts/Minute

Treatment		24	48	72	96	120
				Hours		
Control	$\bar{x}$	2479.0	3444.3	4866.3	11668.0	12053.0
	s	130.1	341.1	500.4	822.5	290.5
.1%	$\bar{x}$	2219.3	2511.7*	3768.0*	9441.3*	10713.7
	s	81.7	69.7	149.0	325.6	793.6
1%	$\bar{x}$	2439.0	2924.0	3653.3*	9561.0*	11052.0
	s	121.6	24.0	366.4	730.3	620.1
5%	$\bar{x}$	2248.0	2312.3*	2775.7*	6225.3*	7850.3*
	s	205.0	241.6	206.2	356.8	827.6
10%	$\bar{x}$	1717.3*	1658.0*	1921.3*	4975.5*	5310.0*
	s	157.0	177.4	7.8	34.6	461.2

STORM 1 SAMPLE 3 - Unfiltered

Control	$\bar{x}$	2479.0	3444.3	4866.3	11668.0	12053.0
	s	130.1	341.1	500.4	822.5	290.5
.1%	$\bar{x}$	2490.0	3341.3	4390.0	11561.0	11645.3
	s	129.2	146.9	165.7	94.8	1063.5
1%	$\bar{x}$	2464.0	2583.3*	4082.3	10035.3	11645.3
	s	176.7	118.1	193.4	1043.6	1581.9
5%	$\bar{x}$	1995.7*	2729.0*	3182.3*	7340.3*	8333.5*
	s	115.8	205.1	458.7	1097.5	98.3
10%	$\bar{x}$	1515.3*	1760.0*	1866.3*	4798.7*	5855.3*
	s	75.9	115.9	206.7	127.0	290.6

*Significant from control

1977-78 SLOPE 1
1/5/78 Assay

Algal Assay: Counts/Minute

Treatment		Hours 24	48	72	96	120
Control	$\bar{x}$	2017.0	3391.0	5170.7	12307.0	11667.7
	s	78.0	79.6	651.3	468.2	822.1
.1%	$\bar{x}$	2034.0	2861.3*	3825.3*	9718.7*	10462.3
	s	158.4	40.3	482.9	796.2	1141.7
1%	$\bar{x}$	2030.3	2760.3*	4136.3	12167.3	14159.0*
	s	122.3	205.9	164.0	1021.2	411.7
5%	$\bar{x}$	2017.0	2741.0	3923.7	12195.0	7394.0*
	s	319.7	404.9	107.5	0	165.2
10%	$\bar{x}$	2269.3*	3013.3	4978.7	13721.7	14874.0
	s	32.3	413.5	587.0	2005.9	2535.3

1977-78 SLOPE 2

Control	$\bar{x}$	2017.0	3391.0	5170.7	12307.0	11667.7
	s	78.0	79.6	651.3	468.2	822.1
.1%	$\bar{x}$	2002.7	2888.3*	4892.0	11046.7	12503.0
	s	62.0	252.4	104.4	1253.8	990.1
1%	$\bar{x}$	2091.3	3484.7	6738.0*	17692.3	21454.5
	s	111.5	154.4	739.8	3263.3	4151.4
5%	$\bar{x}$	2022.7	3932.3*	6899.7*	16190.7	22497.3*
	s	85.2	187.9	591.5	4068.5	1072.7
10%	$\bar{x}$	1724.7*	3627.0	6838.0*	15468.0	22621.0*
	s	81.5	384.7	454.3	2305.3	2841.6

*Significant from control

1977-78 SLOPE 1
1/14/78 Assay - Unfiltered

Algal Assay: Counts/Minute

Treatment		24	72	120
			Hours	
Control	$\bar{x}$	2346.3	16261.0	16350.0
	s	45.1	186.7	334.7
.1%	$\bar{x}$	1976.3*	5913.2*	9234.3*
	s	117.6	4030.9	2249.2
1%	$\bar{x}$	2114.0	11195.3*	6601.3*
	s	174.8	1632.6	622.9
5%	$\bar{x}$	1925.3	10643.3	7454.0*
	s	282.9	1508.0	1051.8
10%	$\bar{x}$	2323.7	10039.7*	8594.3*
	s	74.8	2183.9	1496.2

1977-78 SLOPE 1
1/14/78 Assay Filtered

Control	$\bar{x}$	2346.3	16261.0	16350.0
	s	45.1	186.7	334.7
.1%	$\bar{x}$	2322.3	12675.7*	14410.3
	s	227.3	569.1	2682.8
1%	$\bar{x}$	2850.7*	15192.7	14898.7
	s	89.5	2933.8	2777.8
5%	$\bar{x}$	2301.3	14620.0	15933.3
	s	327.9	2004.2	3542.9
10%	$\bar{x}$	2134.0	14395.3	16234.3
	s	270.5	2211.3	668.3

*Significant from controls

1977-78 SLOPE 2
1/14/78 Assay Unfiltered

Algal Assay: Counts/Minute

Treatment		Hours 24	72	120
Control	$\bar{x}$	1732.0	9488.0	7341.0
	s	112.6	587.9	660.6
.1%	$\bar{x}$	1711.0	9039.0	9372.3
	s	79.3	190.5	1305.5
1%	$\bar{x}$	1576.3	8589.0	8586.7
	s	178.6	750.5	1092.3
5%	$\bar{x}$	1368.0*	7139.0*	6581.3*
	s	163.7	570.7	748.5
10%	$\bar{x}$	1298.7*	5726.0*	6383.6
	s	97.7	76.2	84.6

1977-78 SLOPE 2
1/14/78 Assay Filtered

Control	$\bar{x}$	1732.0	9488.0	7341.0
	s	112.6	587.9	660.6
.1%	$\bar{x}$	1610.0	7129.7*	5424.0*
	s	188.2	207.1	268.1
1%	$\bar{x}$	1458.7	8883.3	6901.3
	s	211.1	778.5	269.4
5%	$\bar{x}$	1539.0	9234.0	5901.0*
	s	125.8	213.6	603.8
10%	$\bar{x}$	1287.7*	7773.3*	7026.0
	s	124.1	504.6	912.1

*Significant from control

1976-77 PLACERVILLE
Storm 2 Sample 1 Unfiltered

Algal Assay: Counts/Minute

Treatment		24	48	72	96	120
Control	$\bar{x}$	4435.0	5663.7		7282.3	8312.7
	s	493.3	160.4		111.1	173.4
.1%	$\bar{x}$	4018.7	4722.0		5801.0	7466.3
	s	126.2	777.9		213.5	199.3
1%	$\bar{x}$	3719.7	3851.7		6678.0	9451.3
	s	305.6	541.5		309.2	1439.3
5%	$\bar{x}$	2262.7	2889.0		3788.3	6048.9
	s	529.6	1113.5		1936.3	1037.9
10%	$\bar{x}$	1777.3	2516.7		2799.3	3753.0
	s	475.1	414.5		1139.6	1059.1

1976-77 PLACERVILLE
Storm 2 Sample 1 Filtered

Algal Assay: Counts/Minute

Treatment		24	48	72	96	120
Control	$\bar{x}$	4435.0	5663.7		7282.3	8312.7
	s	493.3	160.4		111.1	173.4
.1%	$\bar{x}$	3572.0	4338.7		5722.3	6616.3
	s	58.6	433.6		408.6	295.8
1%	$\bar{x}$	3828.3	4581.0		5940.0	7756.7
	s	499.7	882.6		1619.6	1023.4
5%	$\bar{x}$	2484.0	3175.3		4410.3	6537.3
	s	270.0	379.4		1536.6	383.3
10%	$\bar{x}$	1756.0	2170.3		3604.0	5467.0
	s	326.7	581.2		1300.4	137.8

1976-77 PLACERVILLE
Storm 2 Sample 2 Unfiltered

Algal Assay: Counts/Minute

Treatment		Hours 24	48	72	96	120
Control	$\bar{x}$	4214.7	5103.0		7294.0	8098.7
	s	345.2	73.5		726.2	391.9
.1%	$\bar{x}$	4419.3	5836.7		7216.7	8341.0
	s	607.8	630.9		1031.1	309.3
1%	$\bar{x}$	4496.3	6195.7		7002.7	8845.0
	s	457.8	306.3		324.9	210.1
5%	$\bar{x}$	3097.3	5358.0		7957.7	14615.3
	s	195.4	550.7		511.2	159.5
10%	$\bar{x}$	2045.7	3219.0		4099.0	7794.3
	s	165.4	21.4		810.8	720.6

1976-77 PLACERVILLE
Storm 2 Sample 1 Filtered

Algal Assay: Counts/Minute

Treatment		Hours 24	48	72	96	120
Control	$\bar{x}$	4217.7	5103.0		7294.0	8098.7
	s	345.2	73.5		726.2	391.9
.1%	$\bar{x}$	4444.3	4950.3		7149.0	8881.7
	s	410.0	720.4		801.1	899.9
1%	$\bar{x}$	4401.3	5309.0		7791.7	11330.0
	s	242.4	384.8		1427.5	221.6
5%	$\bar{x}$	3431.7	4995.7		1427.5	12295.3
	s	129.6	1043.7		736.5	319.7
10%	$\bar{x}$		3563.0		5299.7	10720.3
	s		420.9		611.7	380.7

1976-77 PLACERVILLE
Storm 2 Sample 6 Unfiltered

Algal Assay: Counts/Minute

Treatment		Hours 24	48	72	96	120
Control	$\bar{x}$	4214.7	5103.0		7294.0	8098.7
	s	345.2	73.5		726.2	391.9
.1%	$\bar{x}$	4408.0	6417.7		7895.3	10550.0
	s	194.8	272.3		498.3	609.8
1%	$\bar{x}$	4238.7	5823.0		7913.7	10209.0
	s	100.9	281.8		688.4	279.1
5%	$\bar{x}$	3450.7	4832.7		7824.7	11835.0
	s	115.7	108.1		381.6	1147.5
10%	$\bar{x}$	3272.7	4350.3		6390.7	9121.0
	s	513.7	129.9		446.2	124.3

1976-77 PLACERVILLE
Storm 2 Sample 10 Unfiltered

Algal Assay: Counts/Minute

Treatment		Hours 24	48	72	96	120
Control	$\bar{x}$	4214.7	5103.0		7294.0	8098.7
	s	345.2	73.5		726.2	391.9
.1%	$\bar{x}$	4242.0	6334.0		7732.3	9901.7
	s	172.7	215.6		925.1	98.0
1%	$\bar{x}$	4000.0	6003.3		7707.7	10315.7
	s	27.7	100.7		427.5	319.1
5%	$\bar{x}$	4119.0	5174.3		8286.7	11939.0
	s	153.0	385.2		524.3	779.2
10%	$\bar{x}$	2942.0	4067.3		5077.0	9806.3
	s	76.4	107.8		88.3	192.5

1976-77 PLACERVILLE
Storm 3 Sample 1 Unfiltered

Algal Assay: Counts/Minute

Treatment		Hours 24	48	72	96	120
Control	$\bar{x}$		2849.3	4494.3	4323.0	4608.7
	s		99.9	52.7	171.1	810.3
.1%	$\bar{x}$		2672.0	2932.0	7386.0	6356.3
	s		45.0	184.0	1324.0	356.1
1%	$\bar{x}$		2623.0	4130.0	5774.5	6635.0
	s		45.1	364.6	610.2	864.1
5%	$\bar{x}$		2108.0	4565.0	6635.0	6712.0
	s		30.6	91.6	86.4	63.6
10%	$\bar{x}$		1564.0	4453.0	5901.0	6386.0
	s		123.1	404.5	123.0	459.6

1976-77 PLACERVILLE
Storm 3 Sample 5 Unfiltered

Algal Assay: Counts/Minute

Treatment		Hours 24	48	72	96	120
Control	$\bar{x}$		2849.3	4494.3	4323.0	4608.7
	s		99.9	52.7	171.1	810.3
.1%	$\bar{x}$		2474.0	3043.0	4430.5	4024.5
	s		240.0	313.7	221.3	34.6
1%	$\bar{x}$		2539.0	3030.0	4962.0	5217.0
	s		188.2	26.2	347.2	479.4
5%	$\bar{x}$		2911.0	3784.0	6600.5	9111.5
	s		431.9	541.6	129.8	248.6
10%	$\bar{x}$		2591.7	6725.3	6262.0	6692.5
	s		989.2	157.9	387.5	221.3

1976-77 PLACERVILLE
Storm 3 Sample 8 Unfiltered

Algal Assay: Counts/Minute

Treatment		24	48	Hours 72	96	120
Control	$\bar{x}$		2386.7	4051.7	4083.3	4003.7
	s		168.0	230.0		
.1%	$\bar{x}$		2330.7	4215.3	6336.0	4645.0
	s		76.1	359.2	256.2	86.6
1%	$\bar{x}$		2786.0	3992.3	4950.5	6108.3
	s		269.9	227.9	34.6	312.9
5%	$\bar{x}$		2607.7	4559.3	6064.0	8173.0
	s		175.8	31.5	207.9	868.3
10%	$\bar{x}$		2119.0	7429.0	6817.0	7551.7
	s		27.6	656.9	387.0	179.7

1976-77 PLACERVILLE
Storm 3 Sample 5 Unfiltered

Algal Assay: Counts/Minute

Treatment		24	48	Hours 72	96	120
Control	$\bar{x}$		2849.3	4494.3	4323.0	4608.7
	s		99.9	52.7	171.1	810.3
.1%	$\bar{x}$		2472.0	3043.0	4430.5	4024.5
	s		240.0	313.7	221.3	34.6
1%	$\bar{x}$		2539.0	3030.0	4962.0	5217.0
	s		188.3	26.2	347.2	479.4
5%	$\bar{x}$		2911.0	3784.0	6600.5	9111.5
	s		431.9	541.6	129.8	248.6
10%	$\bar{x}$		2591.7	6725.3	6262.0	6692.5
	s		989.2	157.9	387.5	221.3

1976-77 PLACERVILLE
Storm 3 Sample 10 Unfiltered

Algal Assay: Counts/Minute

Treatment		Hours 24	48	72	96	120
Control	$\overline{x}$		2386.7	4051.7	4083.3	4403.7
	s		168.0	230.0	605.8	231.5
.1%	$\overline{x}$		2399.5	3132.3	3767.3	4562.3
	s		251.0	311.1	407.6	747.5
1%	$\overline{x}$		2691.5	3179.3	5286.0	5446.3
	s		365.6	77.4	504.9	1107.7
5%	$\overline{x}$		2522.5	3865.0	4888.3	5297.3
	s		67.2	389.8	511.9	578.1
10%	$\overline{x}$		2110.5	7180.3	5892.0	6503.0
	s		222.7	203.3	561.4	879.6

1976-77 WALNUT CREEK
Storm 1 Sample 2 Unfiltered

Algal Assay: Counts/Minute

Treatment		Hours 24	48	72	96	120
Control	$\overline{x}$		12734.7	13073.7	12503.5	10899.3
	s		674.9	775.6	274.2	1674.3
.01%	$\overline{x}$		12661.7	12072.7	12559.7	12270.0
	s		1897.5	1695.9	370.1	682.6
.1%	$\overline{x}$		13827.3	11650.3	11966.3	10981.7
	s		2207.1	632.2	505.8	1073.3
1%	$\overline{x}$		13458.0	12764.7	12997.0	12239.0
	s		1861.5	1018.1	439.2	897.8
10%	$\overline{x}$		11969.7	14359.3	15019.7	14161.3
	s		2006.9	1236.0	1444.1	2039.3

1976-77 WALNUT CREEK
Storm 1 Sample 4 Unfiltered

Algal Assay: Counts/Minute

Treatment		24	48	Hours 72	96	120
Control	$\bar{x}$		12734.7	13073.7	12503.3	10899.3
	s		674.9	775.6	274.2	1674.2
.01%	$\bar{x}$		13346.3	12864.3	13158.0	11242.7
	s		1220.3	1417.9	1681.5	329.2
.1%	$\bar{x}$		13235.3	11241.3	12222.0	11997.3
	s		2079.6	357.1	1571.2	239.8
1%	$\bar{x}$		17524.7	17147.3	16396.0	15021.0
	s		1440.3	343.5	1436.6	679.0
10%	$\bar{x}$		13698.0	16189.0	17547.0	17647.3
	s		2143.8	1822.1	308.0	1697.0

1976-77 WALNUT CREEK
Storm 2 Sample 2 Unfiltered

Algal Assay: Counts/Minute

Treatment		24	48	Hours 72	96	120
Control	$\bar{x}$		11287.3	11811.3	11575.3	13518.3
	s		1986.6	1515.5	1439.1	321.0
.01%	$\bar{x}$		10445.3	9841.3	10016.7	12828.0
	s		661.4	1010.5	501.2	1862.9
.1%	$\bar{x}$		11704.7	12900.7	12669.0	13440.0
	s		1487.5	1542.3	3406.9	952.5
1%	$\bar{x}$		12566.3	14733.0	13008.0	14966.3
	s		1097.4	766.3	1858.1	940.7
10%	$\bar{x}$		7860.0	9656.0	11806.0	13567.0
	s		55.6	139.3	1932.1	1574.4

1976-77 WALNUT CREEK
Storm 2 Sample 5 Unfiltered

Algal Assay: Counts/Minute

Treatment		Hours 24	48	72	96	120
Control	$\bar{x}$		11287.3	11811.3	11575.3	13518.3
	s		1986.6	1515.5	1439.2	321.0
.01%	$\bar{x}$		12019.0	13578.7	15387.7	14310.0
	s		590.3	283.6	243.6	729.2
.1%	$\bar{x}$		11972.7	12860.3	12180.0	14453.0
	s		1501.4	890.9	1519.5	813.1
1%	$\bar{x}$		11643.0	13968.7	15177.3	18109.7
	s		2072.7	1678.2	1490.8	1018.8
10%	$\bar{x}$		5481.7	9450.0	10962.3	16363.0
	s		76.9	106.6	205.2	249.3

1976-77 WALNUT CREEK
Storm 3 Sample I Unfiltered

Algal Assay: Counts/Minute

Treatment		Hours 24	48	72	96	120
Control	$\bar{x}$	6281.3	5787.3	5544.0	5671.3	6028.7
	s	421.7	686.9	396.3	48.9	92.8
.01%	$\bar{x}$	5618.7	5588.3	6079.3	4926.8	7708.7
	s	63.0	113.0	371.3	177.7	437.3
.1%	$\bar{x}$	5321.0	6028.0	6062.3	6804.0	8215.3
	s	130.6	196.4	133.7	123.4	475.5
1%	$\bar{x}$	5618.3	6334.0	6373.0	6997.0	7876.3
	s	31.5	215.6	184.3	221.8	162.7
10%	$\bar{x}$	3165.3	3311.0	5291.7	7331.0	6334.0
	s	55.1	19.1	73.9	151.9	215.6

1976-77 WALNUT CREEK
Storm 3 Sample 3 Unfiltered

Algal Assay: Counts/Minute

Treatment		Hours 24	48	72	96	120
Control	$\bar{x}$	6281.3	5787.3	5544.0	5671.3	6028.7
	s	421.7	686.9	396.3	48.9	93.8
.01%	$\bar{x}$	5953.7	5921.3	7234.7	7348.0	8271.7
	s	106.5	197.0	1031.1	137.8	292.1
.1%	$\bar{x}$	5634.0	5748.0	6251.0	7146.0	8704.3
	s	223.4	88.1	103.9	185.9	336.8
1%	$\bar{x}$	5753.7	6038.0	6688.3	6507.3	7815.0
	s	236.2	349.7	466.4	357.3	158.9
10%	$\bar{x}$	4067.3	3826.3	4257.0	6212.3	7256.3
	s	117.7	109.1	109.0	102.8	322.1

1976-77 WALNUT CREEK
Storm 3 Sample 8 Unfiltered

Algal Assay: Counts/Minute

Treatment		Hours 24	48	72	96	120
Control	$\bar{x}$	6281.3	5787.3	5544.0	5671.3	6028.7
	s	421.7	686.9	396.3	48.9	92.8
.01%	$\bar{x}$	5055.0	5296.7	6415.3	7251.3	7765.3
	s	186.7	213.5	221.5	233.2	400.1
.1%	$\bar{x}$	4696.0	6330.3	6063.3	6715.7	7675.0
	s	95.1	107.2	158.3	208.3	705.3
1%	$\bar{x}$	5079.3	5920.0	6683.0	6809.3	8003.3
	s	473.0	163.4	401.2	260.5	192.0
10%	$\bar{x}$	3877.3	4484.7	5598.3	6949.0	8700.0
	s	94.9	60.0	314.9	128.7	227.0

1976-77 WALNUT CREEK
Storm 3 Sample15 Unfiltered

Algal Assay: Counts/Minute

Treatment		Hours 24	48	72	96	120
Control	$\bar{x}$	6281.3	5787.3	5544.0	5671.3	6028.7
	s	421.7	686.9	396.3	48.9	92.8
.01%	$\bar{x}$	5824.0	5623.7	7347.0	7737.0	8212.0
	s	1253.7	483.4	704.9	157.8	969.9
.1%	$\bar{x}$	5631.0	7231.0	7352.0	7112.0	6281.0
	s	943.5	152.4	623.2	139.6	493.9
1%	$\bar{x}$	6025.3	6668.3	7304.0	7671.7	6800.3
	s	198.4	244.9	487.4	969.3	683.0
10%	$\bar{x}$	2760.7	4355.3	6697.0	7198.7	7252.3
	s	214.9	476.1	68.1	222.2	297.7

197 -7 WALNUT CREEK
Storm 4 Sample 1 Unfiltered

Algal Assay: Counts/Minute

Treatment		Hours 24	48	72	96	120
Control	$\bar{x}$	3023.7	2690.0	3067.3	5863.0	3176.7
	s	232.0	209.4	16.2	178.6	161.4
.1%	$\bar{x}$	3430.0	2679.0	3294.0	5898.0	3659.0
	s	24.7	47.7	244.9	650.9	167.1
1%	$\bar{x}$	2730.0	2763.0	3638.0	6726.7	3958.0
	s	31.2	215.5	111.7	391.1	36.8
5%	$\bar{x}$	2496.0	3336.0	4464.0	7610.0	5354.0
	s	149.0	349.9	202.4	885.0	512.7
10%	$\bar{x}$	2242.0	2959.0	4454.3	7940.3	5980.3
	s	175.6	245.7	257.7	535.9	200.5

1977-78 WALNUT CREEK
Storm 4 Sample 8 Unfiltered

Algal Assay: Counts/Minute

Treatment		Hours 24	48	72	96	120
Control	$\bar{x}$	3023.7	2690.0	3067.3	5863.0	3176.7
	s	232.0	209.4	16.2	178.6	161.4
.1%	$\bar{x}$	2774.7	2680.3	2917.7	6499.7	3119.0
	s	458.2	508.9	212.8	926.0	439.6
1%	$\bar{x}$	3095.0	3336.0	3696.3	7555.7	3931.0
	s	161.6	744.6	825.5	1156.7	163.6
5%	$\bar{x}$	3074.7	3853.7	4558.0	8302.3	5726.7
	s	174.1	394.9	102.3	688.3	330.7
10%	$\bar{x}$	2683.3	3270.3	4705.3	8914.0	6787.3
	s	169.2	101.3	269.5	900.7	568.8

1977-78 WALNUT CREEK
Storm 4 Sample 11 Unfiltered

Algal Assay: Counts/Minute

Treatment		Hours 24	48	72	96	120
Control	$\bar{x}$	2961.3	2575.7	3127.0	7017.7	3542.3
	s	9.8	234.2	154.7	501.3	38.3
.1%	$\bar{x}$	2784.0	3124.3	3265.7	6363.0	3610.3
	s	647.4	339.8	79.8	265.2	745.6
1%	$\bar{x}$	3153.3	3103.0	3675.3	8009.7	4642.0
	s	235.6	278.9	534.0	954.0	872.9
5%	$\bar{x}$	2875.7	3361.0	4434.7	9337.0	5195.0
	s	360.8	65.3	151.4	289.4	322.5
10%	$\bar{x}$	1963.0	2403.3	3254.3	7030.7	4766.7
	s	201.0	38.6	137.7	132.0	387.2

1977-78 WALNUT CREEK
Storm 4 Sample 13 Unfiltered

Algal Assay: Counts/Minute

Treatment		24	48	Hours 72	96	120
Control	$\bar{x}$	2961.3	2575.7	2127.0	7017.7	3542.3
	s	9.8	234.5	154.7	501.3	38.2
.1%	$\bar{x}$	2542.0	2571.3	2697.0	5789.7	3100.0
	s	488.8	272.2	494.3	883.6	730.2
1%	$\bar{x}$	2763.7	2945.3	4038.0	8004.0	4459.0
	s	391.0	283.0	421.5	187.4	510.1
5%	$\bar{x}$	2230.0	2982.0	4320.0	8180.0	5974.7
	s	286.4	333.9	384.3	257.5	303.0
10%	$\bar{x}$	1623.0	1751.3	2625.3	5671.5	4014.7
	s	100.9	30.4	200.4	498.5	159.3

1976-77 LOS ANGELES
Storm 1 Sample 1 Unfiltered

Algal Assay: Counts/Minute

Treatment		24	48	Hours 72	96	120
Control	$\bar{x}$	6281.3	5787.3	5544.0	5671.3	5497.0
	s	421.9	686.9	396.3	48.9	171.0
.01%	$\bar{x}$	6378.3	6152.3	5595.3	6194.7	6638.3
	s	288.1	407.6	280.1	295.6	396.2
.1%	$\bar{x}$	5952.3	5761.3	5959.3	5683.7	5655.7
	s	35.5	352.4	254.0	117.2	223.6
1%	$\bar{x}$	4260.3	4135.0	5749.7	5183.3	6394.0
	s	181.7	131.0	153.7	123.9	474.9
10%	$\bar{x}$	1188.3	1036.7	1713.0	1590.7	1787.0
	s	41.3	66.0	39.4	48.0	57.7

1976-77 LOS ANGELES
Storm 1 Sample 5 Unfiltered

Algal Assay: Counts/Minute

Treatment		Hours 24	48	72	96	120
Control	$\bar{x}$	6281.3	5787.3	5544.0	5671.3	5497.0
	s	421.9	686.9	396.3	48.9	171.9
.01%	$\bar{x}$	5748.3	5780.3	7183.7	5883.0	6433.7
	s	80.8	307.4	917.3	568.8	122.6
.1%	$\bar{x}$	6239.7	5811.7	5677.0	5520.0	6715.0
	s	168.7	274.8	483.1	634.4	126.8
1%	$\bar{x}$	3929.3	5022.7	7653.0	5765.0	6111.0
	s	489.3	411.6	478.2	1087.0	978.4
10%	$\bar{x}$	1464.3	1680.0	2026.0	1772.7	1612.7
	s	87.4	164.9	198.5	191.7	128.7

1976-77 LOS ANGELES
Storm 1 Sample 6 Unfiltered

Algal Assay: Counts/Minute

Treatment		Hours 24	48	72	96	120
Control	$\bar{x}$	5521.7	6295.7	6838.0	7055.0	6777.3
	s	483.3	243.3	209.7	421.4	238.5
.01%	$\bar{x}$	5579.7	5710.3	6743.0	5917.0	6333.3
	s	544.8	499.9	778.4	443.4	629.5
.1%	$\bar{x}$	5805.0	6184.0	7253.3	6484.7	6792.0
	s	966.8	822.8	1483.7	1106.1	220.9
1%	$\bar{x}$	4942.7	6604.7	7868.0	7967.0	8652.3
	s	506.2	648.4	628.8	1208.6	975.1
10%	$\bar{x}$	1774.0	2229.7	3734.3	3940.0	2521.0
	s	47.3	512.2	160.4	221.4	246.1

1976-77 LOS ANGELES
Storm 1 Sample 7 Unfiltered

Algal Assay: Counts/Minute

Treatment		Hours 24	48	72	96	120
Control	$\bar{x}$	5521.7	6295.7	6838.0	7055.0	6777.3
	s	483.3	243.4	209.7	421.4	238.5
.01%	$\bar{x}$	5052.6	5621.3	5179.7	5751.7	5479.0
	s	459.1	164.6	240.8	372.9	569.9
.1%	$\bar{x}$	5482.0	5489.7	5983.0	6630.0	9193.7
	s	50.8	695.3	532.0	133.1	189.9
1%	$\bar{x}$	4671.0	4820.7	5636.0	6830.7	6867.0
	s	367.7	304.3	250.8	114.8	116.0
10%	$\bar{x}$	1639.7	1791.0	2738.0	3268.3	3067.7
	s	54.4	108.1	112.0	48.9	24.9

1976-77 LOS ANGELES
Storm 1 Sample 10 Unfiltered

Algal Assay: Counts/Minute

Treatment		Hours 24	48	72	96	120
Control	$\bar{x}$	6281.3	5787.3	5544.0	5671.3	5497.0
	s	421.9	686.9	396.3	48.9	171.9
.01%	$\bar{x}$	5217.3	6385.0	6308.0	6266.0	6294.7
	s	266.7	380.7	422.9	695.9	222.4
.1%	$\bar{x}$	5708.7	6809.3	6584.3	7463.0	6632.3
	s	730.0	260.5	225.7	111.5	315.2
1%	$\bar{x}$	4723.7	5032.0	6266.3	7729.3	7594.7
	s	224.0	227.6	392.8	665.9	461.8
10%	$\bar{x}$	2310.0	2840.0	2265.3	2764.0	2908.0
	s	42.5	175.8	103.1	84.0	67.8

1976-77 LOS ANGELES
Storm 2 Sample 1 Unfiltered

Algal Assay: Counts/Minute

Treatment		24	48	Hours 72	96	120
Control	$\bar{x}$	945.0	854.3	1087.3	1084.7	1015.0
	s	56.6	13.4	199.4	9.1	121.1
.01%	$\bar{x}$		1369.0	1033.0	1041.7	1207.0
	s		403.2	56.8	18.6	71.7
.1%	$\bar{x}$		1060.0	1174.7	1064.7	1278.3
	s		183.8	216.5	61.5	208.5
1%	$\bar{x}$	1032.3	915.7	900.3	919.0	916.3
	s	53.5	88.8	114.3	149.7	42.5
5%	$\bar{x}$	1598.6	702.3	633.7	684.3	635.3
	s	31.1	61.6	68.4	25.7	76.6
10%	$\bar{x}$	403.3	426.7	452.0	493.7	516.7
	s	33.9	93.8	91.0	66.4	11.7

1976-77 LOS ANGELES
Storm 2 Sample 2 Unfiltered

Algal Assay: Counts/Minute

Treatment		24	48	Hours 72	96	120
Control	$\bar{x}$	945.0	854.3	1078.3	1084.7	1015.0
	s	56.6	13.4	199.4	9.1	121.1
.01%	$\bar{x}$	858.0	981.0	1066.7	1380.3	1144.0
	s	45.5	107.9	17.9	139.0	68.4
.1%	$\bar{x}$	878.0	974.3	1016.3	1016.3	1215.3
	s	107.2	64.9	116.4	112.2	105.9
1%	$\bar{x}$	870.3	1058.3	1106.7	1085.7	1082.7
	s	69.1	31.0	113.3	86.1	77.1
5%	$\bar{x}$	461.7	767.7	810.7	842.0	963.0
	s	53.8	88.5	94.9	89.9	52.8
10%	$\bar{x}$	406.7	475.7	525.7	595.3	648.7
	s	22.1	28.0	44.8	65.7	61.3

1976-77 LOS ANGELES
Storm 2 Sample 7 Unfiltered

Algal Assay: Counts/Minute

Treatment		Hours 24	48	72	96	120
Control	$\bar{x}$	945.0	854.3	1087.3	1084.7	1015.0
	s	56.6	13.4	199.4	9.1	121.1
.01%	$\bar{x}$	778.7	943.0	1032.3	1161.3	1127.7
	s	96.5	68.1	204.6	97.9	28.9
.1%	$\bar{x}$	861.0	1010.0	924.0	885.0	1001.7
	s	79.8	151.6	66.5	186.7	91.7
1%	$\bar{x}$	829.7	868.3	1054.7	1053.7	1090.7
	s	54.8	69.6	40.8	41.8	8.9
5%	$\bar{x}$	537.3	623.7	705.7	644.7	602.3
	s	36.8	55.2	100.4	73.1	28.0
10%	$\bar{x}$	476.7	410.0	502.7	483.0	461.7
	s	73.1	57.5	59.3	49.3	31.6

1976-77 LOS ANGELES
Storm 3 Sample 1 Unfiltered

Algal Assay: Counts/Minute

Treatment		Hours 24	48	72	96	120
Control	$\bar{x}$		7588.0	8549.3	6689.0	8404.0
	s		1035.9	207.3	31.1	100.4
.01%	$\bar{x}$		6303.0	6969.0	7922.3	8138.3
	s		730.7	770.8	577.8	374.1
.1%	$\bar{x}$		7183.3	7678.7	7484.0	10712.7
	s		261.8	265.3	182.1	245.6
1%	$\bar{x}$		793.6	804.3	895.7	1115.3
	s		69.0	50.1	76.5	113.2
5%	$\bar{x}$		292.7	265.0	268.0	318.7
	s		16.0	14.5	11.1	25.8
10%	$\bar{x}$		188.3	176.3	167.7	228.3
	s		11.2	10.0	6.4	28.4

1976-77 LOS ANGELES
Storm 3 Sample 1 Filtered

Algal Assay: Counts/Minute

Treatment		24	48	Hours 72	96	120
Control	$\bar{x}$		7588.0	8549.3	6689.0	8404.0
	s		1035.9	207.3	31.1	100.4
.1%	$\bar{x}$		7292.7	7828.7	7163.0	10037.7
	s		710.5	641.5	191.5	254.6
1%	$\bar{x}$		797.7	779.0	882.3	1100.0
	s		42.4	63.4	54.1	79.3
5%	$\bar{x}$		332.3	370.0	364.0	339.0
	s		11.9	50.7	46.9	70.9
10%	$\bar{x}$		213.7	247.7	218.0	279.3
	s		20.7	52.4	30.8	26.6

1976-77 LOS ANGELES
Storm 3 Sample 2 Unfiltered

Algal Assay: Counts/Minute

Treatment		24	48	Hours 72	96	120
Control	$\bar{x}$		6076.7	6633.7	6518.3	8995.0
	s		126.5	850.1	696.9	701.8
.01%	$\bar{x}$		5015.0	6692.7	6165.7	8363.0
	s		543.1	510.7	404.4	280.0
.1%	$\bar{x}$		6443.7	9275.3	6737.0	8599.0
	s		437.5	1525.6	326.7	1429.4
1%	$\bar{x}$		2786.7	5832.3	6413.7	7833.3
	s		1250.4	1716.8	662.8	1124.1
5%	$\bar{x}$		1053.4	2397.3	2191.3	2543.5
	s		91.9	106.2	104.4	502.8
10%	$\bar{x}$		1139.0	1661.0	1543.7	1678.3
	s		152.7	189.9	160.1	76.9

1976-77 LOS ANGELES
Storm 3 Sample 2 Filtered

Algal Assay: Counts/Minute

Treatment		24	48	Hours 72	96	120
Control	$\bar{x}$		6076.7	6633.7	6518.7	8995.0
	s		126.5	850.1	696.9	701.8
.01%	$\bar{x}$		6921.3	6484.3	6403.3	6107.0
	s		1340.1	213.3	447.6	555.6
.1%	$\bar{x}$		6421.3	6697.2	6107.0	7947.0
	s		496.5	773.1	555.6	1290.5
1%	$\bar{x}$		4520.7	6221.6	5370.7	7075.3
	s		326.6	595.0	727.8	861.4
5%	$\bar{x}$		1992.0	2207.0	2322.0	3339.3
	s		14.4	239.6	147.5	379.8
10%	$\bar{x}$		1260.3	1754.3	1594.7	2236.0
	s		210.9	266.0	367.9	356.8

1976-77 LOS ANGELES
Storm 3 Sample 6 Unfiltered

Algal Assay: Counts/Minute

Treatment		24	48	Hours 72	96	120
Control	$\bar{x}$		6076.7	6633.7	6518.3	8993.0
	s		126.5	850.1	696.9	701.8
.01%	$\bar{x}$		5274.0	6949.7	6591.3	10020.3
	s		290.9	241.5	353.2	550.5
.1%	$\bar{x}$		5819.7	8480.0	6855.0	8784.3
	s		219.9	256.2	249.4	399.2
1%	$\bar{x}$		3742.0	4757.7	5614.7	8861.7
	s		243.5	204.6	485.0	1115.8
5%	$\bar{x}$		2138.0	2552.0	2710.7	2773.7
	s		137.1	63.9	59.0	119.1
10%	$\bar{x}$		1479.7	1782.0	2017.7	1966.3
	s		36.0	228.4	235.9	71.8

1976-77 LOS ANGELES
Storm 3 Sample 6 Filtered

Algal Assay: Counts/Minute

Treatment		Hours 24	48	72	96	120
Control	$\bar{x}$		6076.7	6833.7	6518.3	8993.0
	s		126.5	850.1	696.9	701.8
.01%	$\bar{x}$		6222.0	6638.0	6959.7	9202.0
	s		322.4	396.2	368.8	625.3
.1%	$\bar{x}$		5994.0	6221.7	5685.7	8353.0
	s		237.8	254.3	181.2	503.0
1%	$\bar{x}$		4585.7	5823.7	4814.3	7317.0
	s		370.7	287.3	462.7	447.4
5%	$\bar{x}$		2250.0	2025.7	2647.7	3936.7
	s		93.2	63.8	92.5	302.4
10%	$\bar{x}$		1777.3	1834.0	2002.0	2320.7
	s		52.5	84.0	78.0	43.4

1977-78 LOS ANGELES
Storm 1 Sample 1 Unfiltered

Algal Assay: Counts/Minute

Treatment		Hours 24	48	72	96	120
Control	$\bar{x}$	2479.0	3444.3	4866.3	11668.0	12053.0
	s	130.1	341.1	500.4	822.5	290.5
.1%	$\bar{x}$	3186.0	4034.0	5151.0	13095.3	17280.0
	s	100.4	524.7	318.2	1683.6	6305.9
1%	$\bar{x}$	3788.7	3139.0	3537.0	8940.0	12196.3
	s	879.3	166.9	325.9	451.1	149.0
5%	$\bar{x}$	1851.7	1767.3	1903.7	4527.0	5056.3
	s	222.7	149.0	25.8	447.0	206.3
10%	$\bar{x}$	1169.0	1019.7	946.0	2706.0	2733.0
	s	41.0	19.7	50.4	616.3	63.6

1977-78 LOS ANGELES
Storm 1 Sample 2 Unfiltered

Algal Assay: Counts/Minute

Treatment		Hours 24	48	72	96	120
Control	$\bar{x}$	2479.0	3444.3	4866.3	11668.0	12053.0
	s	130.1	341.1	500.4	822.5	290.5
.1%	$\bar{x}$	2219.3	2511.7	3768.0	9441.3	10713.7
	s	81.7	69.7	149.0	325.6	793.6
1%	$\bar{x}$	2439.0	2924.0	3653.3	9561.0	11052.0
	s	121.6	24.0	366.4	730.3	620.1
5%	$\bar{x}$	2248.0	2312.3	2775.7	6225.3	7850.3
	s	205.0	241.6	206.2	356.8	827.6
10%	$\bar{x}$	1717.3	1658.0	1921.3	4975.5	5310.0
	s	157.0	177.4	7.8	34.6	461.2

1977-78 LOS ANGELES
Storm 1 Sample 3 Unfiltered

Algal Assay: Counts/Minute

Treatment		Hours 24	48	72	96	120
Control	$\bar{x}$	2479.0	3444.3	4866.3	11668.0	12053.0
	s	130.1	341.1	500.4	822.5	290.5
.1%	$\bar{x}$	2490.0	3341.3	4390.0	11561.0	11645.3
	s	129.2	146.9	165.7	94.8	1063.5
1%	$\bar{x}$	2464.0	2583.3	4082.3	10035.3	11645.3
	s	176.7	118.1	193.4	1043.6	1581.9
5%	$\bar{x}$	1995.7	2729.0	3182.3	7340.3	8333.5
	s	115.8	205.1	458.7	1097.5	98.3
10%	$\bar{x}$	1515.3	1760.0	1866.3	4798.7	5855.3
	s	75.9	115.9	206.7	127.0	290.6

1977-78 SLOPE 1
1/5/78 Assay

Algal Assay: Counts/Minute

Treatment		24	48	Hours 72	96	120
Control	$\bar{x}$	2017.0	3391.0	5170.7	12307.0	11667.7
	s	78.0	79.6	651.3	468.2	822.1
.1%	$\bar{x}$	2034.0	2861.3	3825.3	9718.7	10462.3
	s	158.4	40.3	482.9	796.2	1141.7
1%	$\bar{x}$	2030.3	2760.3	4136.3	12167.3	14159.0
	s	122.3	205.9	164.0	1021.2	411.7
5%	$\bar{x}$	2017.0	2741.0	3923.7	12195.0	7394.0
	s	319.7	404.9	107.5	0	165.2
10%	$\bar{x}$	2269.3	3013.3	4978.7	13721.7	14874.0
	s	32.3	413.5	587.0	2005.9	2535.3

1977-78 SLOPE 2
1/5/78 Assay

Algal Assay: Counts/Minute

Treatment		24	48	Hours 72	96	120
Control	$\bar{x}$	2017.0	3391.0	5170.7	12307.0	11667.7
	s	78.0	79.6	651.3	468.2	822.1
.1%	$\bar{x}$	2002.7	2888.3	4892.0	11046.7	12503.0
	s	62.0	252.4	104.4	1253.8	990.1
1%	$\bar{x}$	2091.3	3484.7	6738.0	17692.3	21454.5
	s	111.5	154.4	739.8	3263.3	4151.4
5%	$\bar{x}$	2022.7	3932.3	6899.7	16190.7	22497.3
	s	85.2	187.9	591.5	4068.5	1072.7
10%	$\bar{x}$	1724.7	3627.0	6838.0	15468.0	22621.0
	s	81.5	384.7	454.3	2305.3	2841.6

1977-78 SLOPE 1
1/14/78 Assay Unfiltered

Algal Assay: Counts/Minute

Treatment		Hours 24	72	120
Control	$\bar{x}$	2346.3	16261.0	16350.0
	s	45.1	186.7	334.7
.1%	$\bar{x}$	1976.3	5913.2	9234.3
	s	117.6	4030.9	2249.2
1%	$\bar{x}$	2114.0	11195.3	6601.3
	s	174.8	1632.6	622.9
5%	$\bar{x}$	1925.3	10643.3	7454.0
	s	282.9	1508.0	1051.8
10%	$\bar{x}$	2323.7	10039.7	8594.3
	s	74.8	2183.9	1496.2

1977-78 SLOPE 1
1/14/78 Assay Filtered

Algal Assay: Counts/Minute

Treatment		Hours 24	72	120
Control	$\bar{x}$	2346.3	16261.0	16350.0
	s	45.1	186.7	334.7
.1%	$\bar{x}$	2322.3	12675.7	14410.3
	s	227.3	569.1	2682.8
1%	$\bar{x}$	2850.7	15192.7	14898.7
	s	89.5	2933.8	2777.8
5%	$\bar{x}$	2301.3	14620.0	15933.3
	s	327.9	2004.2	3542.9
10%	$\bar{x}$	2134.0	14395.3	16234.3
	s	270.5	2211.3	668.3

1977-78 SLOPE 2
1/14/78 Assay Unfiltered

Algal Assay: Counts/Minute

Treatment		Hours 24	72	120
Control	$\bar{x}$	1732.0	9488.0	7341.0
	s	112.6	587.9	660.6
.1%	$\bar{x}$	1711.0	9039.0	9372.3
	s	79.3	190.5	1305.5
1%	$\bar{x}$	1576.3	8589.0	8586.7
	s	178.6	750.5	1092.3
5%	$\bar{x}$	1368.0	7139.0	6581.3
	s	163.7	570.7	748.5
10%	$\bar{x}$	1298.7	5726.0	6383.6
	s	97.7	76.2	84.6

1977-78 SLOPE 2
1/14/78 Assay Filtered

Algal Assay: Counts/Minute

Treatment		Hours 24	72	120
Control	$\bar{x}$	1732.0	9488.0	7341.0
	s	112.6	587.9	660.6
.1%	$\bar{x}$	1610.0	7129.7	5424.0
	s	188.2	207.1	268.1
1%	$\bar{x}$	1458.7	8883.3	6901.3
	s	211.1	778.5	269.4
5%	$\bar{x}$	1539.0	9234.0	5901.0
	s	125.8	213.6	603.8
10%	$\bar{x}$	1287.7	7773.3	7026.0
	s	124.1	504.6	912.1

APPENDIX D

LAKE NATOMAS WATER QUALITY

STORET DATE 79/01/10

A0718000 5141203
38 38 10.0 121 13 20.0 3
AMERICAN RIVER BELOW NIMBUS DAM
06067 CALIFORNIA
AMERICAN RIVER 140991
LOWER AMERICAN RIVER
21CAL-1
0000 CLASS 00

/TYPA/AMBNT/STREAM

PARAMETER				NUMBER	MEAN	VARIANCE	STAN DEV	COEF VAR	STAND ER	MAXIMUM	MINIMUM	BEG DATE	END DATE
00011	WATER	TEMP	FAHN	64	57.3359	42.6438	6.53023	.113894	.816278	71.0000	47.5000	75/02/04	77/09/27
00027	COLLECT	AGENCY	CODE	36	2163.00	-.822E+01	.000000		.000000	2163.00	2163.00	75/02/04	76/07/20
00032	CLOUD	COVER	PERCENT	63	15.5556	1189.61	34.4907	2.21726	4.34541	100.000	.000000	75/02/04	77/09/27
00060	STREAM	FLOW	CFS	1	3520.00					3520.00	3520.00	75/07/08	75/07/08
00061	STREAM	FLOW,	INST-CFS	64	2122.42	2693648	1641.23	.773283	205.154	7510.00	250.000	75/02/04	77/09/27
00065	STREAM	STAGE	FEET	20	7.74949	.499100	.706470	.091163	.157972	9.49000	6.92000	75/03/04	75/12/23
00076	TURB	TRBIDMTR	HACH FTU	64	1.81250	7.64682	2.76529	1.52568	.345661	21.0000	1.00000	75/02/04	77/09/27
00094	CNDUCTVY	FIELD	MICROMHO	64	59.5000	163.841	12.8000	.215127	1.60001	90.0000	40.0000	75/02/04	77/09/27
00095	CNDUCTVY	AT 25C	MICROMHO	64	59.6250	167.952	12.9596	.217352	1.61995	93.0000	41.0000	75/02/04	77/09/27
00300	DO		MG/L	64	10.3437	2.01259	1.41866	.137152	.177332	13.9000	7.70000	75/02/04	77/09/27
00335	COD	LOWLEVEL	MG/L	64	1.71562	.627702	.792277	.461802	.099035	3.70000	.400000	75/02/04	77/09/27
00400	PH		SU	64	7.10620	.019605	.140017	.019704	.017502	7.40000	6.80000	75/02/04	77/09/27
00403	LAB	PH	SU	64	7.25151	.052653	.229462	.031643	.028683	8.00000	6.80000	75/02/04	77/09/27
00440	HCO3 ION	HCO3	MG/L	10	27.8000	26.6237	5.15981	.185605	1.63168	36.0000	20.0000	75/04/22	77/07/26
00445	CO3 ION	CO3	MG/L	10	1.00000	.000000	.000000		.000000	1.00000	1.00000	75/04/22	77/07/26
00530	RESIDUE	TOT NFLT	MG/L	64	3.32812	57.4660	7.58064	2.27775	.947579	62.0000	.000000	75/02/04	77/09/27
00610	NH3-N	TOTAL	MG/L	64	.016406	.000493	.022209	1.35368	.002776	.130000	.010000	75/02/04	77/09/27
00613	NO2-N	DISS	MG/L	36	.000556	.000005	.002323	4.18159	.000387	.010000	.000000	75/02/04	76/07/20
00615	NO2-N	TOTAL	MG/L	64	.010000	-.650E-09	.000000		.000000	.010000	.010000	75/02/04	77/09/27
00618	NO3-N	DISS	MG/L	36	.025833	.000808	.028423	1.10024	.004737	.100000	.000000	75/02/04	76/07/20
00620	NO3-N	TOTAL	MG/L	64	.025781	.000491	.022168	.859877	.002771	.100000	.010000	75/02/04	77/09/27
00625	TOT KJEL	N	MG/L	64	.129687	.008152	.090288	.696200	.011286	.600000	.100000	75/02/04	77/09/27
00629	TOT ORG	KJELDL N	MG/L	35	.127714	.012536	.111964	.876678	.018925	.600000	.000000	75/02/18	76/07/20
00631	NO2&NO3	N-DISS	MG/L	36	.026389	.000829	.028800	1.09137	.004800	.100000	.000000	75/02/04	76/07/20
00665	PHUS-TOT		MG/L P	64	.020156	.000427	.020663	1.02515	.002583	.120000	.010000	75/02/04	77/09/27
00671	PHUS-DIS	ORTHO	MG/L P	64	.011719	.000046	.006797	.580040	.000850	.060000	.010000	75/02/04	77/09/27
00680	T ORG C	C	MG/L	63	1.68412	.175561	.419000	.248794	.052789	3.00000	.900000	75/02/04	77/09/27
00681	D ORG C	C	MG/L	3	1.56667	.013333	.115470	.073704	.066667	1.70000	1.50000	76/04/20	76/05/18
00900	TOT HARD	CACO3	MG/L	10	24.3000	35.5677	5.96387	.245427	1.88594	34.0000	17.0000	75/04/22	77/07/26
00915	CALCIUM	CA,DISS	MG/L	10	6.36000	2.28936	1.51306	.237903	.478473	9.40000	4.70000	75/04/22	77/07/26
00925	MGNSIUM	MG,DISS	MG/L	10	2.07000	.520116	.721191	.348402	.228061	3.40000	1.20000	75/04/22	77/07/26
00930	SODIUM	NA,DISS	MG/L	10	2.70000	.324456	.569610	.210967	.180127	3.90000	2.10000	75/04/22	77/07/26
00935	PTSSIUM	K,DISS	MG/L	10	.640000	.016000	.126492	.197644	.040000	.900000	.400000	75/04/22	77/07/26
00940	CHLORIDE	CL	MG/L	10	2.03000	4.43345	2.10558	1.03723	.665841	7.10000	.000000	75/04/22	77/07/26
00945	SULFATE	SO4-TOT	MG/L	10	2.54000	.991572	.995777	.392039	.314892	3.60000	.600000	75/04/22	77/07/26
00946	SULFATE	SO4-DISS	MG/L	6	.023167	.000133	.011514	.496998	.004700	.033000	.006000	75/04/22	76/07/20
00955	SILICA	DISOLVED	MG/L	10	8.66000	1.60270	1.26598	.146187	.400338	11.0000	7.00000	75/04/22	77/07/26
01002	ARSENIC	AS,TOT	UG/L	32	10.0000	.000000	.000000		.000000	10.0000	10.0000	75/02/18	77/09/27
01027	CADMIUM	CD,TOT	UG/L	32	10.0000	.000000	.000000		.000000	10.0000	10.0000	75/02/18	77/09/27
01034	CHROMIUM	CR,TOT	UG/L	32	10.3125	3.12513	1.76780	.171423	.312506	20.0000	10.00000	75/02/18	77/09/27
01042	COPPER	CU.TOT	UG/L	32	9.99999	.000118	.010869	.001087	.001921	10.0000	10.00000	75/02/18	77/09/27
01045	IRON	FE,TOT	UG/L	64	161.312	57074.1	238.902	1.48099	29.8627	1800.00	20.0000	75/02/04	77/09/27
01051	LEAD	PB,TOT	UG/L	32	10.3125	3.12509	1.76779	.171423	.312505	20.0000	10.00000	75/02/18	77/09/27
01055	MANGNESE	MN	UG/L	32	19.0624	621.675	24.9334	1.30799	4.40764	150.000	10.00000	75/02/18	77/09/27
01092	ZINC	ZN,TOT	UG/L	31	10.9677	9.03245	3.00540	.274022	.539787	20.0000	10.00000	75/02/18	77/09/27
23318	INVALID	PAR	NUMBER	1	.700000					.700000	.700000	76/09/28	76/09/28
31505	TOT COLI	MPN CONF	/100ML	74	470.959	1904020	1379.86	2.92990	160.406	9200.00	4.00000	75/02/04	77/09/27
31615	FEC COLI	MPNECMED	/100ML	74	38.5986	14073.1	118.630	3.07343	13.7905	930.000	2.00000	75/02/04	77/09/27
31677	FECSTREP	MPNADEVA	/100ML	74	64.4135	87916.5	296.507	4.60319	34.4683	2400.00	2.00000	75/02/04	77/09/27
32211	CHLRPHYL	A UG/L	CORRECTD	28	2.78214	8.25263	2.87274	1.03256	.542897	12.0000	.600000	75/05/20	77/09/27
32218	PHEOPHTN	A	UG/L	26	1.10769	1.85914	1.36350	1.23094	.267405	4.60000	.100000	75/07/22	77/09/27
38260	MBAS		MG/L	33	.010606	.000012	.003482	.328260	.000606	.030000	.010000	75/02/18	77/09/27
38620	INVALID	PAR	NUMBER	1	.010000					.010000	.010000	76/01/20	76/01/20
39040	DEF	WTR SMPL	UG/L	5	.000000	.000000	.000000		.000000	.000000	.000000	75/04/22	76/04/20
39153	ATRZSIMZ	WHL SMPL	UG/L	1	.020000					.020000	.020000	77/04/19	77/04/19
49010	UNKNOWNC	WHL SMPL	UG/L	1	.010000					.010000	.010000	77/04/19	77/04/19
70300	RESIDUE	DISS-180	C MG/L	10	42.9000	79.2127	8.90015	.207463	2.81447	60.0000	29.0000	75/04/22	77/07/26
71851	NITRATE	DISS-NO3	MG/L	27	.118518	.017721	.133120	1.12320	.025619	.400000	.000000	75/03/18	76/07/20
71900	MERCURY	HG,TOTAL	UG/L	29	.103448	.000345	.018571	.179524	.003449	.200000	.100000	75/02/18	77/09/27
74052	CHLOMDYC	PERMIT	GENERAL	9	.003000	.000016	.003969	1.32288	.001323	.010000	.001000	75/04/22	77/07/26
84028	ANALYZE	AGENCY	CODE	36	TEXT	TEXT	TEXT		TEXT	TEXT	TEXT	75/02/04	76/07/20
84029	FIELD	IDENT	NUMBER	36	TEXT	TEXT	TEXT		TEXT	TEXT	TEXT	75/02/04	76/07/20